15 Cents DECEMBER 1907 $1.00 a year

THE FOUNDRY

A Lafayette Among Molding Machines

THE UNIVERSAL SYSTEM OF MACHINE MOLDING

INVENTED AND INTRODUCED BY

PH. BONVILLAIN & E. RONCERAY

PARIS, FRANCE.

Gage by which to control ramming.

Pop Throttle. No Cup Leathers.

Sand Frame always handy. Strikes off in swinging.

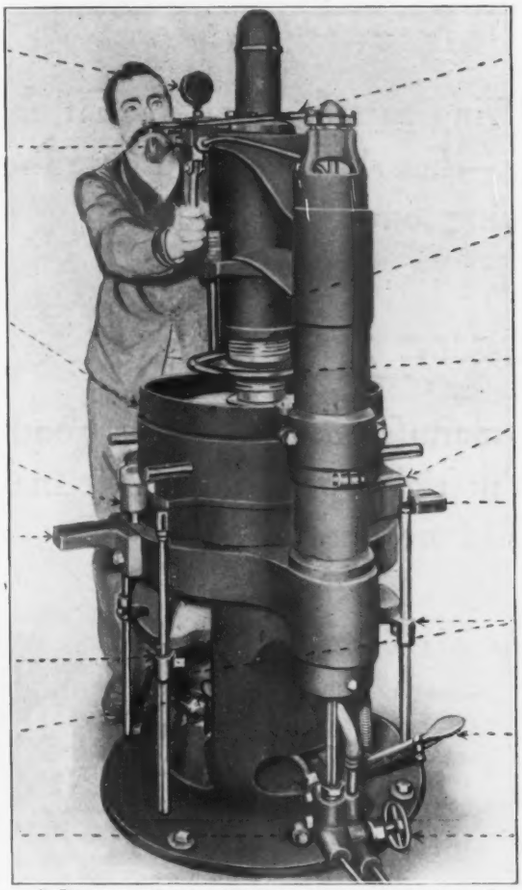
Flask Pins in Pattern Carrier—No Mismatch from Machine—Pins Drawn.

Extension Bracket for longer flasks.

Pattern Drawing Posts set here for all degrees of "Cut Flasks."

Adjusts by simply turning a Milled Nut the amount of double or bottom ramming.

Controls speed of pattern draft.



Copper Tubing much less expensive than Hose.

This is Main Ramming Plunger. There is another under base of machine which draws patterns—also does the double ramming.

Adjustment so that there is no idle stroke in ramming.

Stripping Plate cast perfect without pattern for it—free—not ground against patterns by defective guide.

Fine adjustment for even lifting of stripping plate.

Swinging and Sliding Arms place any size and shape of mold within reach of machines.

Draws patterns with the foot—hands busy.

Controls speed of ramming.

A 3 STANDARD MACHINE—Average Mold 22" x 32"
Will Draw Patterns of any mold it can ram.

THE SIMPLEST COMPLETE MOLDING MACHINES BUILT.
One Plunger Rams—One Draws Patterns—Often One Does Both.

No Complication to Maintain Pattern Match. No Dash Liquid to help Air Draw Patterns. No Air at all—Cylinders ¼ Dia. of Air Cylinders.

Selling Agents for the United States

The E. H. Mumford Co. 1315 Race St., Philadelphia, Pa.

1907---

It's the Same Old Story.

You who have stood by us through thick and thin, through good and bad, you who are for us, we feel sure, will be glad to know that the year just closing has been

The Biggest in Our History.

The gratifying part of it all is that each year---since 1874---has shown a handsome increase over the preceding one.

There's a Reason for This.

We must manufacture the right goods, and sell them at the right price or this remarkable increase would not be ours. So---

Get in the band wagon---

Stick to the successful ones.

The S. Obermayer Co.

Cincinnati Chicago Pittsburg

EVERYTHING YOU NEED IN YOUR FOUNDRY

Millett Portable Core Oven

1500 MILLETT CORE OVENS

in operation confirms the foundrymen's ability to detect good values and good ovens

WHAT YOUR CORE ROOM MAKES is determined largely by the oven you procure for it.

Continuous Service and well baked cores are assured with the MILLETT Core Oven.

THE DOUBLE DOOR---one closing as the other opens---prevents waste in heat and permits you to get any core without effecting the continuous working of the oven.

In point of economy, cleanliness and quality work the MILLETT excels.

We Look For Your Inquiry.

The Millett Core Oven Co.

Brightwood, Mass., U. S. A.

SALES AGENTS

PHILADELPHIA, PA. J. W. Paxson Co.

DETROIT, MICH. F. B. Stevens

PITTSBURG, PA. J. S. McCormick Co.

NEW YORK CITY Thos. W. Pangborn Co.

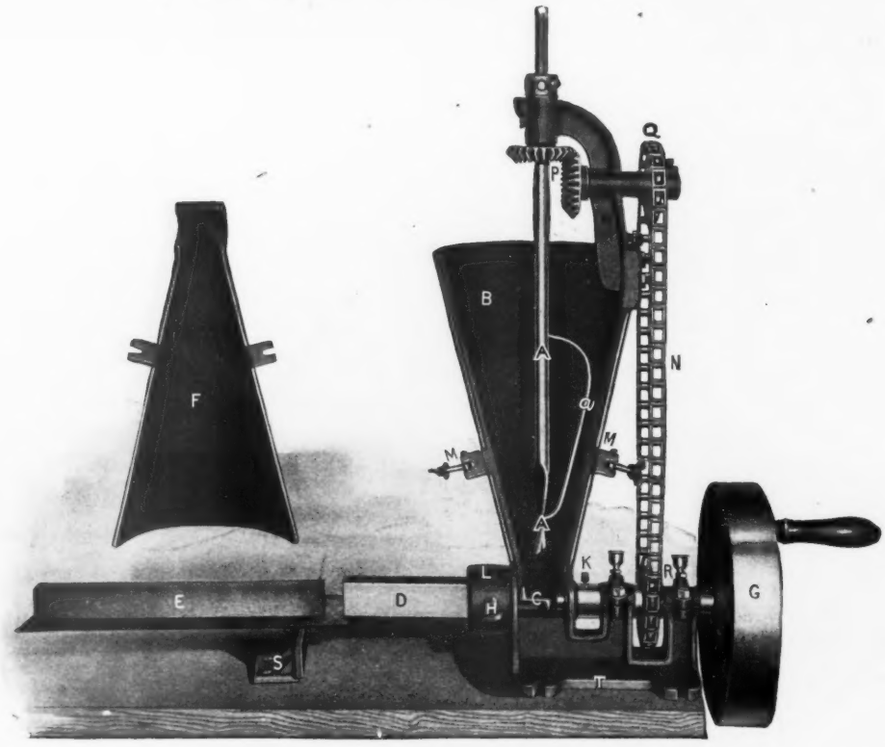
LONDON, ENGLAND J. W. Jackman & Co.

PARIS, FRANCE Fenwick Freres & Co.

Millett Stationary Core Oven

Hammer Core Machine

(With Hopper Cover Removed)



THE above cut was made especially to show the advantages of the upright or force feed, "A" being a device peculiar to this machine, fully covered by our patent and not employed in any other machine. It agitates the sand and prevents it from getting caked or set in the hopper "B." By means of the twisted blade "A," the sand is forced upon the conveyor "C," which transmits and packs it into the tube or die "D," which gives form to the core. The force feed insures steady and regular feed and supplies sand to the conveyor as long as there is any in the hopper. The twisted conveyor or bit delivers the sand in such a manner that the core is one continuous core of equal strength throughout, and not a series of short cores liable to part easily, as formed by plunger machines.

The vent in the core is formed by the pin on the end of the conveyor which projects into the tube, while the core is being formed, and the vent may be made larger or smaller by changing the size of the pin when the bit is made.

This machine makes straight cores in any shape from ⅜ to 3 inches in diameter.

Every machine sold on 30 days trial—perfect satisfaction guaranteed.

Send for our New Catalog---just out

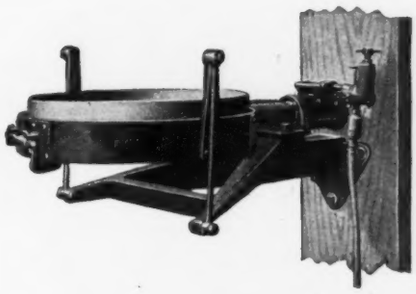
THOS. W. PANGBORN CO.
90 West Street NEW YORK
Exclusive sales-agents for the
Atlantic Coast States, Vermont, W. Virginia, Pennsylvania and Eastern Canada

BROWN SPECIALTY-MACHINERY CO.
Cor. Jackson Boulevard & Clinton Street
CHICAGO

SURPRISINGLY

FEW FOUNDRIES ARE WITHOUT THE USE OF ONE OR MORE OF THESE

LABOR SAVING MACHINES



A LABORER AND ONE MACHINE WILL RIDDLE MORE SAND IN **AN HOUR** THAN HE WILL SCREEN BY HAND IN **A DAY.**

ENGINEERING

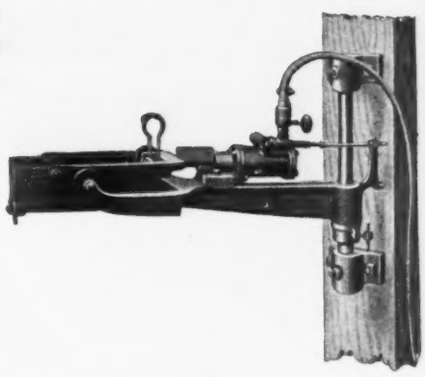
HANNA HE SHAKERS

CHICAGO

WORKS

REQUIRE VERY LITTLE AIR TO OPERATE

IT'S A **LABOR SAVER** TO THE WORKMAN AND A **TIME SAVER** TO THE EMPLOYER



DON'T RIDDLE YOUR SAND BY HAND

HANNA ENGINEERING WORKS

820 Elston Ave., Chicago

Thos. W. Pangborn Co., 90 West St., New York City.
Pneumatic Engineering Appliances Co. Ltd., Palace Chambers, Westminster, London, Eng.
S. Obermayer Co., Chicago, Cincinnati.

Schwartz Melting and Refining FURNACE

In sizes from 100 lbs. per heat to 10,000 lbs. Capacity.

The Pioneer in Brass and Copper melting furnaces. The most Economical and Durable.

The Ohio Brass Co.

The Westinghouse Air Brake Co.

A PARTIAL LIST OF USERS.

J. B. Clow & Son
Crane Co.
Manning, Maxwell & Moore
Hewitt Mfg. Co.
Atlantic Brass Co.
Otis Elevator Co.
U. S. Navy Yards
General Electric Co.
Roc Steel Co., Middlesex, Eng.
Ludlow Valve Co.
Erie R. R.

D. & R. G. R. R.
C. R. I. & P. R. R.
L. & N. R. R.
Gr. Northern R. R.
Smeeth Copper Co.
Best Mfg. Co.
International Steam Pump Co.
American Locomotive Co.
Magnus Metal Co.
Westinghouse Electric Co.
Aluminum Co. of America

Westinghouse Air Brake Co.
Newport News Ship Building Co.
British Admiralty, Chatham, Eng.
Nathan Mfg. Co.
C. B. & Q. R. R.
A. T. & S. Fe R. R.
Seaboard Air Line
N. & W. R. R.
B. & M. R. R.
Blake & Knowles Pump Co.
J. I. Case Plow Works

"Sold on guaranteed results"

Write for new catalogue.

The Hawley Down Draft Furnace Co.

CHICAGO U. S. A. NEW YORK

Steel Founders, Your Attention!

For Melting

Ferro-Vanadium, Manganese or Silicon

Place your order for

The "Steele Harvey"

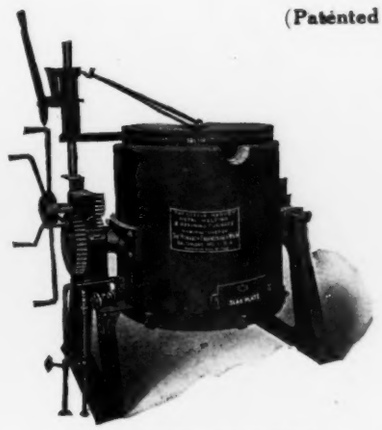
CRUCIBLE METAL MELTING FURNACE

used in connection with Fuel Oil or Natural Gas and Air. Now employed in various **Steel Plants** for above purpose, also for

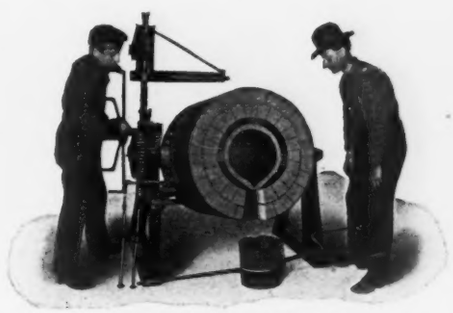
BRASS FOUNDRY PRACTICE

We cannot keep apace with orders. Absolutely the only practical and economical furnace on the market today

STANDARD STYLE
(Patented in the United States and all foreign countries)



IN MELTING POSITION



IN POURING POSITION

The Sayre Stamping Company, of Sayre, Pa., have had a wonderful experience with our furnaces. In our No. 60 Tilting Furnace their crucibles have run successively 58, 60, 66, 72, 78, 82 heats. Simply amazing and incomprehensible, but absolutely true. They are now operating 3 furnaces, thus saving over coke method, fully **50 per cent.**

Capacities from 120 to 1500 lbs. per heat.

Prices reasonable, shipment at once, settlements as desired. Operated subject to acceptance.

The Monarch Engineering & Mfg. Co.

BALTIMORE, MD., U. S. A.

Works: Curtis Bay, Md.

CARR & SPEER, 120 Liberty St., New York

PACIFIC COAST:
A. L. Taylor, 9 California St., San Francisco
EUROPEAN DEPOT: J. W. Jackman & Co., London

Cherry Valley Iron

A Soft, Strong and Uniform quality for the foundry, obtained by careful selection of ores and closest attention at the furnaces. You want better castings---We will help you get them. Make machinery castings with

AMERICA'S BEST

in the mix. Cherry Valley Iron Castings machine easily. You may be granted a small concession in price on an off-grade Iron, but you pay dearly for it in the end. Know, as hundreds of foundrymen do, those qualities that make famous the

CHERRY VALLEY IRON.

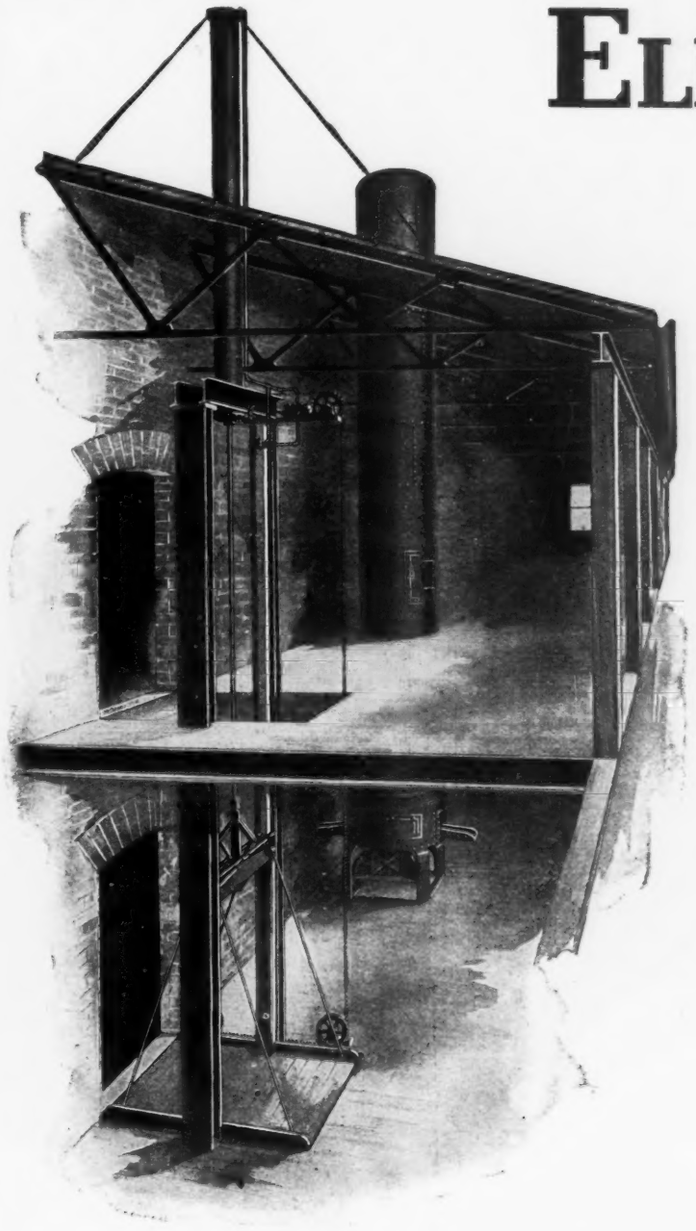
United Iron & Steel Company

SUCCESSORS TO

THE CHERRY VALLEY IRON CO.

PITTSBURG, PA.

PNEUMATIC FOUNDRY ELEVATORS



AIR
COMPRESSORS

AIR
HOISTS

TRAVELLING
CRANES

All styles of
JIB CRANES
and
CASTING
BREAKERS

Write

Curtis & Co. Manufacturing Co.

ST. LOUIS, MO.

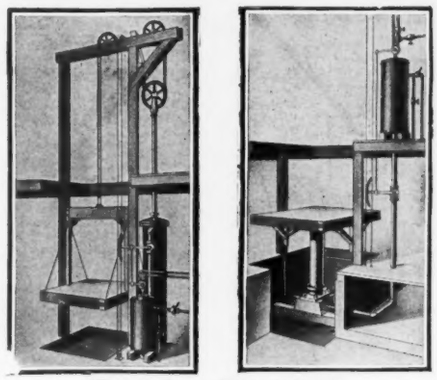
A. E. Hoermann, No. 41 Park Row, New York

Baird Machinery Co., Pittsburg

Hill, Clark & Co., Boston

"Any Man Who Don't Put in the Steam Hydraulic is a Fool!"

That is what the engineer of the greatest single interest in the world said. His company had sent him out to investigate the Steam Hydraulic with a view to installing them in their newest and most up-to-date foundry. They are being installed.



Foundry Elevators

And isn't a man a fool who doesn't buy an elevator that is guaranteed costless to run and costless for repairs.

Isn't a man a fool who doesn't follow the experience of the best engineers.

Isn't a man the biggest kind of a fool if he won't even write and get a circular of the most wonderful elevator ever known.

The Costless Hydraulic Elevator—For example: See that lower cut. Three in use at Ajax Metal Co., Philadelphia. By actual test to put 100 tons from floor level to wagon level cost one and one-fifth cents. No, not 1 1-5 cents per ton, but 1 1-5 cents for whole 100 tons.

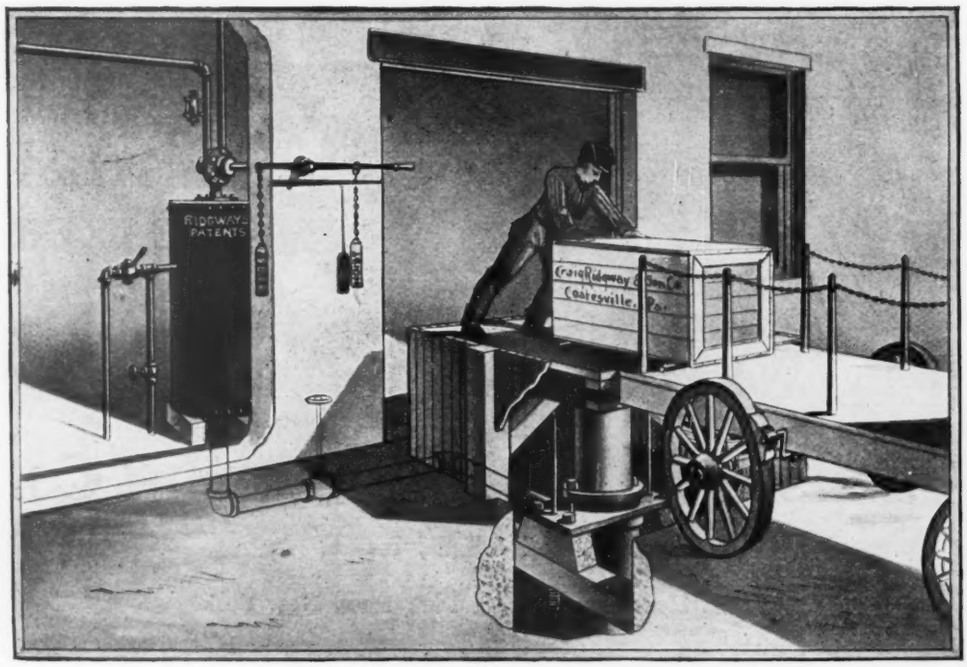
Do you wonder we are supplying all the smart people in the land with these splendid machines?

Why don't you find out what it means to

Hook'er to the Biler

CRAIG RIDGWAY & SON COMPANY

Coatesville, Pa.



Greatest Modern Money Saver

THE FOUNDRY

Vol. 31, No. 4 CLEVELAND, OHIO, DECEMBER, 1907 Whole No. 184

THE MANUFACTURE OF CAST IRON PIPE

Description of the Continuous Process of Making Pipe in the Largest Pipe Foundry in the World

A NEW PLANT for the continuous manufacture of cast iron pipe, equipped for an estimated output of 750 tons daily, has just been completed at Scottdale, Pa., by the United States Cast Iron Pipe & Foundry Co. In designing the plant the pit method generally used has been adhered to, but tables have been installed on which the flasks revolve for the successive molding, drying, casting and shaking out operations. The molds are rammed by machine, which is a distinct departure from the practice now prevailing not only in this country, but Europe as well.

The four casting pits have been installed in two units, each served by three jib cranes. The crane which serves the rammers of each pit, removes the flasks after the molds have been poured and places them horizontally on skids over a sand pit where the clamps are removed and the pipe shaken out of the flasks. The sand is tempered in the pit and is removed by the same crane and placed within reach of the molding machines. The electric ramming machines, one of which is shown in Fig. 7, are anchored in the center of the pit, having arms extending the radii of the tables to bring the ramming devices directly over the flasks. Each table is served by a jib crane which sets the cores and pours the iron.

The 32 core ovens are built in units of eight, each serving one pit, two being located at either end of the foundry and the other two, in the center, backing each other. The coremaking machines are distributed along one side of the plant opposite the cupolas, each machine serving one oven. The four cupolas, which melt continuously, have been installed in a furnace house erected at the center of one side of the plant, the ladles being delivered to the jib cranes by an overhead tramrail system. The four finishing sheds are built at right angles to the main building, each serving one table. The movement of the pipe after being cast is toward

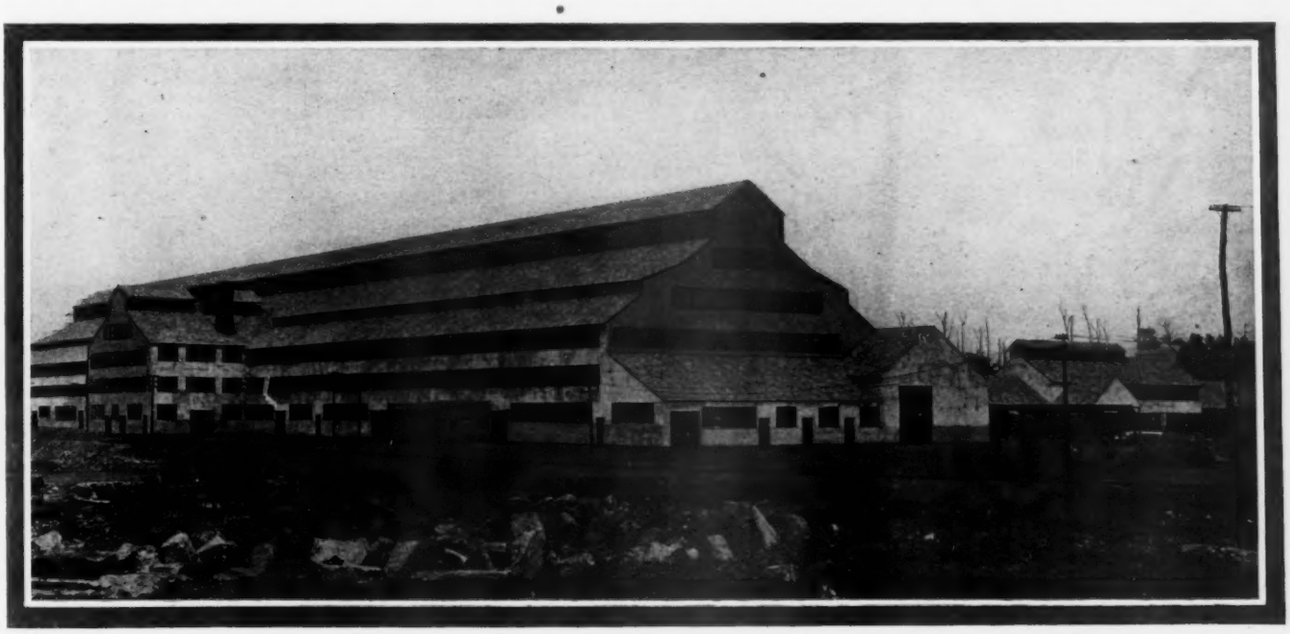


FIG. 1—NEW PLANT OF THE UNITED STATES CAST IRON PIPE & FOUNDRY CO., SCOTTDALE, PA. VIEW SHOWING THE FURNACE HOUSE

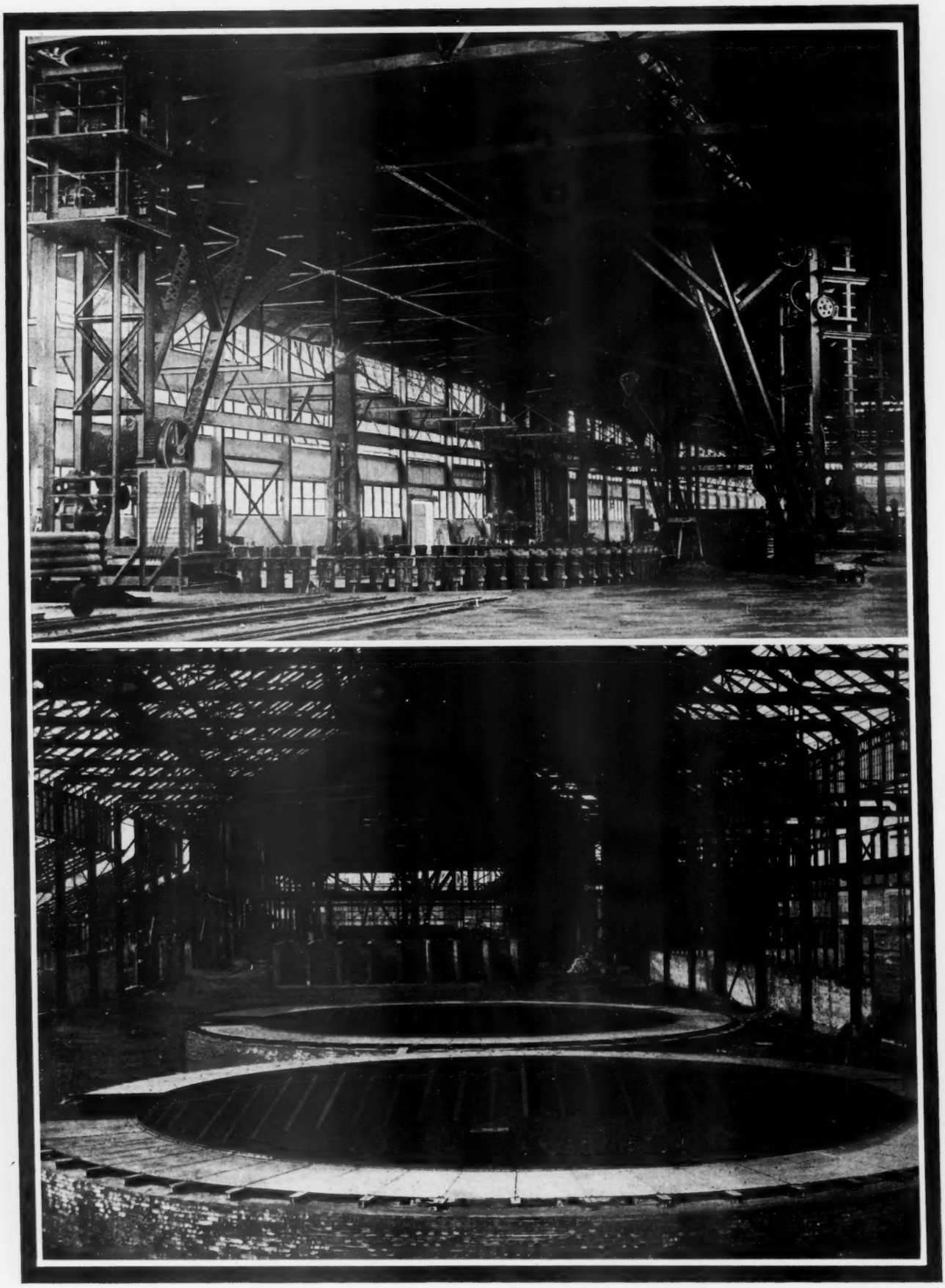


FIG. 2—VIEW OF ONE OF THE REVOLVING TABLES, SHOWING JIB CRANES
FIG. 3—CASTING PITS UNDER CONSTRUCTION, WITH ONE UNIT OF EIGHT CORE OVENS IN THE BACKGROUND

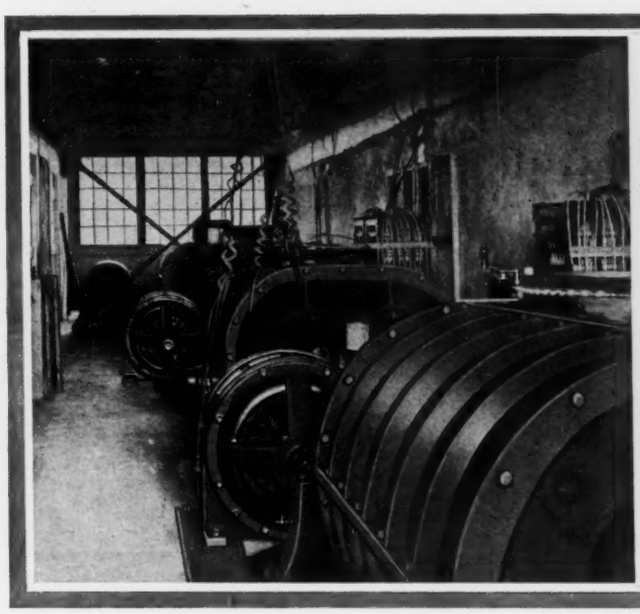


FIG. 4—BLOWER ROOM ON MEZZANINE FLOOR

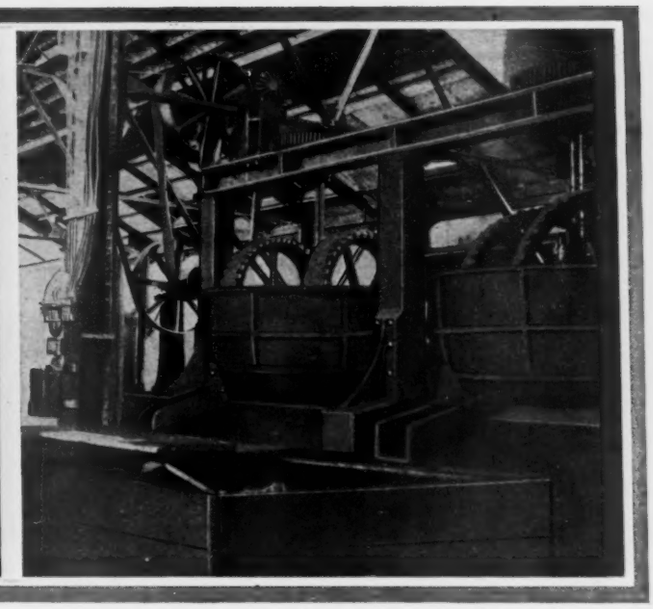


FIG. 5—A PAIR OF MUD MILLS

the cars in which they are to be loaded, or the yard where they are to be stocked, in the meantime passing the cleaners, chippers, pipe heating ovens, dipping tanks, scales and testing machines.

The Foundry.

The main building extends north and south and is approximately 125 feet wide and 700 feet long. The cupola house is located at the middle of the west side of the main building and is 40 x 70 feet. The blower room is located on a mezzanine floor underneath the charging platform. The four finishing sheds for cleaning, coating and testing the pipe extend in an easterly direction from the main building. Each shed serves one of the four revolving tables, those at either end being 350 feet long and are provided with heating ovens, scales, dipping tanks and testing machines, while the sheds extending from the two middle tables are connected to those at either end by means of transfer runways over which the pipe is conveyed to the dipping tanks and test houses.

The boiler and compressor house, Fig. 17, has been erected between the two shorter sheds where the steel tank and tower for the water supply are located. All of these buildings have tile roofs with side walls of concrete, the lower portion being 9 inches thick, while the upper section between the windows is reinforced and is 2 inches in thickness. The floors of the blower room and the charging platform are also made of reinforced concrete, as are the walls of the blower room, which are made heavier to resist the suction of the blowers.

Light and Ventilation.

To prevent the accumulation of cinders on the roof its pitch is somewhat greater than ordinarily specified. Proper ventilation is secured through louvres on the side of the main dormer and the additional continuous louvres at the break in the roof. The windows over the core ovens are pivoted with shaft sprocket wheels leading to the floor and provide additional ventilation. Ample lighting fa-

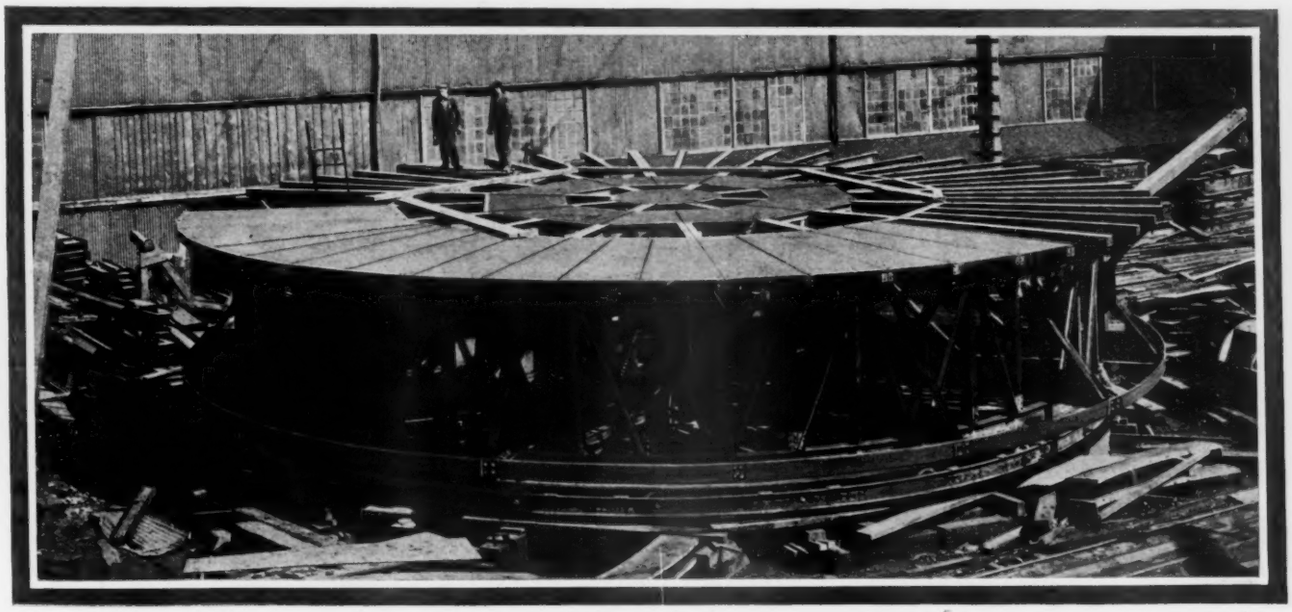


FIG. 6—REVOLVING TABLE UNDER CONSTRUCTION

FIG. 9—JIB CRANES USED FOR SETTING THE CORES AND POURING THE IRON
FIG. 10—THE FOUR CUPOLAS

FIG. 7—CASTING PITS SHOWING ELECTRIC RAMMER
FIG. 8—CUPOLA CHARGING FLOOR

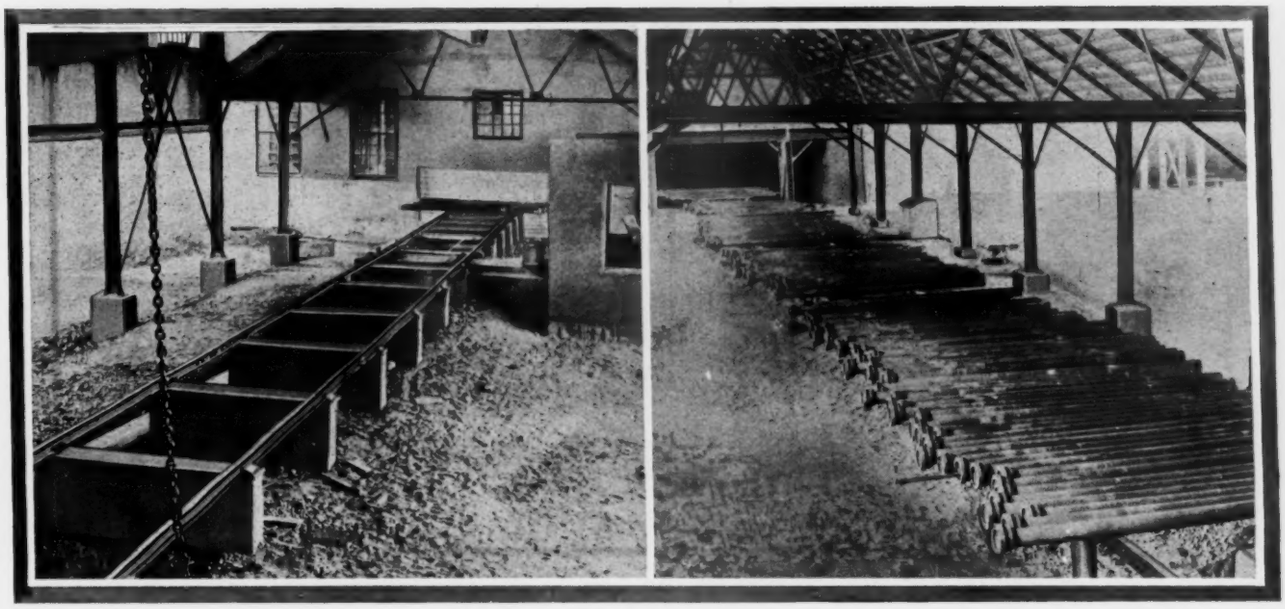


FIG. 11—SKID FROM THE HEATING OVEN TO DIPPING TANK

FIG. 12—CLEANING SHED SHOWING SKID FOR CASTING PIT

cilities are provided by large and continuous windows in the sides and ends of the building, as may be seen in Figs. 1 and 19. The doors throughout the plant are of steel, rolling shutter type. The frame work is steel throughout and all of the buildings are fireproof. To withstand the action of fumes and gases which are prevalent in a plant of this kind the sheet metal work is of copper and the tiled roof gives additional protection.

Owing to the large number of trolleys and overhead runways installed in the plant the bottom chords of the roof trusses have been braced with heavy angles. The jib cranes serving each of the revolving pits have been especially designed by the engineering department of this concern and are built for heavy service. The plant was erected under the direction of F. A. Field, consulting engineer of the company, and J. E. Tinstman, superintendent of the foundry.

Revolving Tables.

The four revolving tables are distinct departures from ordinary pipe foundry practice. The United States Cast Iron Pipe & Foundry Co. installed the first revolving table in this country at its Chattanooga plant. The diameter of the Scottdale pits has, however, been increased to 74 feet as compared with 27 feet 10 inches at Chattanooga. The revolving pit tables for carrying the flasks are supported on heavy concrete foundations surmounted by circular steel tracks. The tables are built up of structural steel shapes and are covered with steel plates. They are pivoted in the center and also travel on an outside track. Twenty per cent of the load is carried on the center and 80 per cent on the track. Each table has a capacity of 94 double flasks for pipe up to 6 inches in diameter, or 58 double flasks for 12-inch pipe. The total weight of the table, including the flasks with the castings, is 700 tons. Each table has a diameter of 47 feet, the pit proper being 74 feet in diameter. Each table is revolved

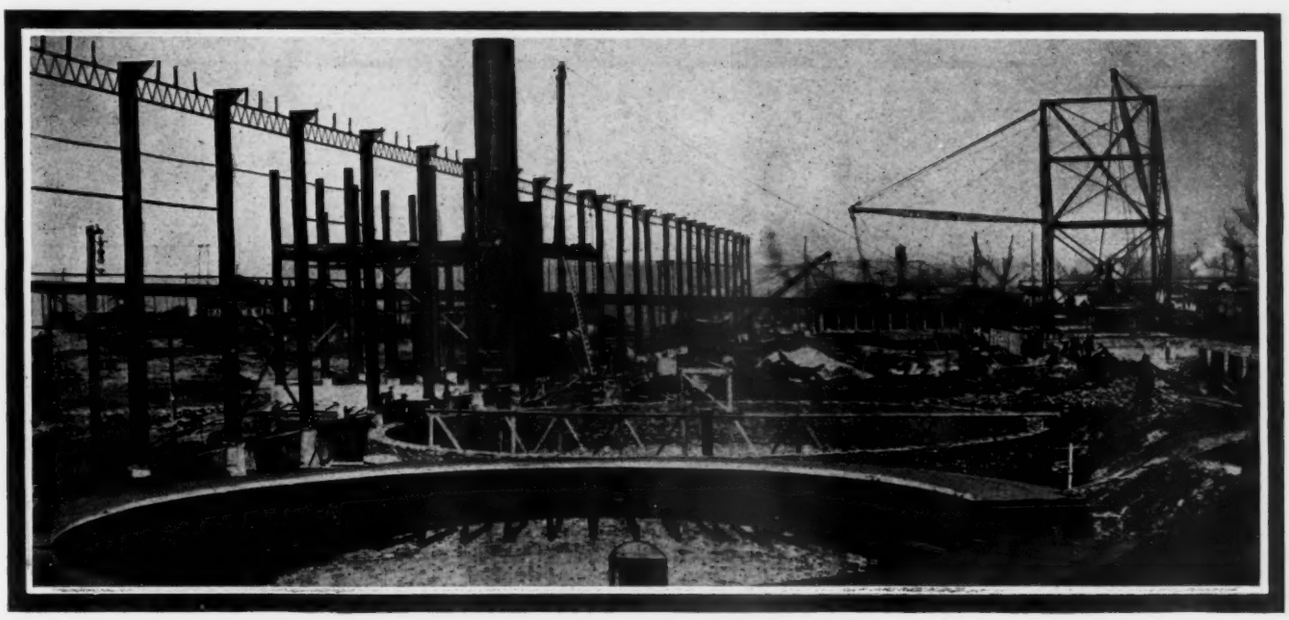


FIG. 13—CASTING PITS UNDER CONSTRUCTION

FIG. 14—EXPANDED METAL AND CONCRETE FOUNDRY CURTAIN WALL CONSTRUCTION

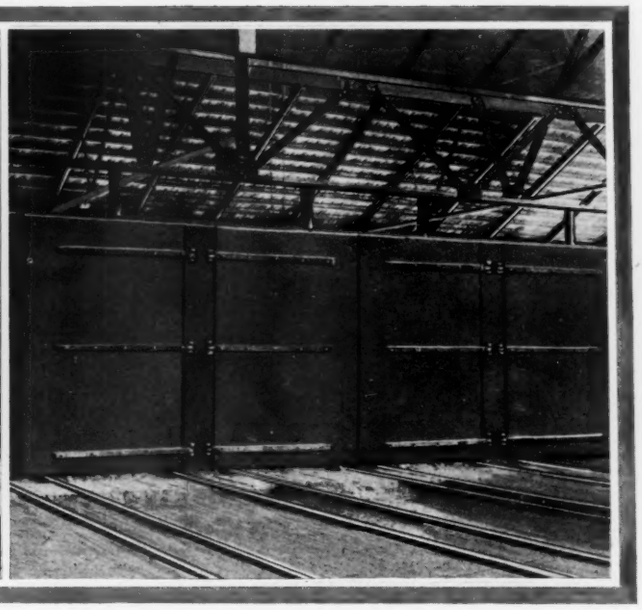


FIG. 15—SECTION OF ONE OF THE CORE OVEN UNITS

by a 10-horsepower alternating current motor, and is provided with an electrically operated ramming machine. The rammer has a rotary motion around the pattern and by its use the sand is packed more uniformly than by hand. With the revolving tables three casts will be made daily. This can be readily accomplished, inasmuch as the molds after being rammed pass over coke fires in the pits and are dried before the cores have been set. The coke stoves extend two-thirds of the circumference of the pit and the gases pass up through the molds, which practically serve as chimneys. Immediately after the molds have been dried and the cores have been set the table is revolved and the molds are poured. In the meantime, other flasks which have been shaken out and which have again been returned to the table by one of the jib cranes are being rammed and passed over the coke fire, the cores set, and the operation repeated. Prevailing practice provides for the drying of the molds at night and their casting the next day. By this continuous operation the mold is finished and the casting made within a little over three hours.

Crane Service.

Each of the revolving tables is commanded by two electric jib cranes, the one located between the tables of each unit serving both, making three cranes for each unit. There are four cranes of 10 tons capacity each which pour the iron and set the cores and two that shake out the pipe, return the flasks to the tables and serve the electric rammers as the tables revolve. The cranes serving the pits revolve at a speed of 560 feet per minute and have an effective radius of 38 feet. They are provided with three motors each, one of 50 horsepower capacity for hoisting, one of 15 horsepower for slewing, and one of 10 horsepower for racking, and are controlled by foot brakes. There are two speed attachments for

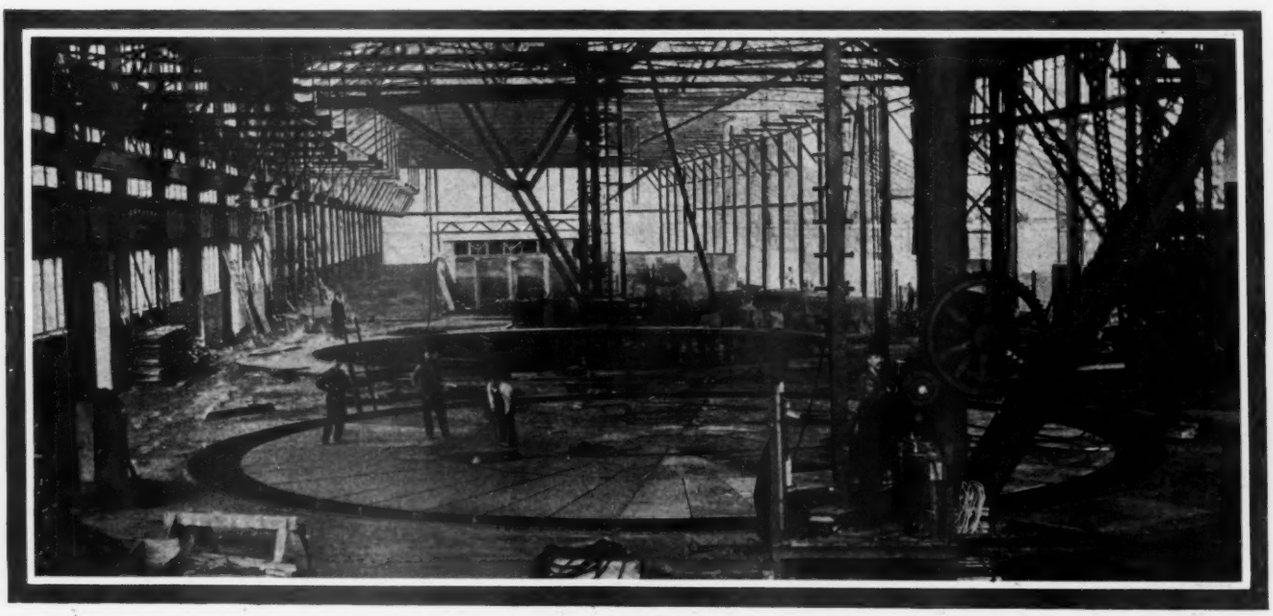


FIG. 16—INSTALLATION OF ONE OF THE TABLES

FIG. 17—COMPRESSOR HOUSE

FIG. 18—DIPPING TANK AND TEST HOUSE

the hoists of the cranes, one giving a speed of 150 feet and the other of 95 feet per minute. The low speed is used for handling hot metal and the high speed for the flasks and cores. The speed of the rack on the jib casting cranes is 85 feet per minute.

Cupolas.

The furnace room is 40 x 70 feet and is equipped with four 84-inch cupolas. Fig. 10, having melting capacities ranging from 14 to 18 tons per hour. Thus far they have averaged 16 tons per hour on a 10-hour run, melting with a ratio of over 11¼ tons of iron to one ton of coke, including the bed. While the shells of the cupolas are 84 inches in diameter, the diameter inside of the lining is 66 inches. They are of the regular Newten patent type installed by the Northern Engineering Works, Detroit, but the stacks have butt riveted joints and the air chambers are somewhat deeper than the standard types.

The blower room, Fig. 4, as previously stated, is located on a mezzanine floor underneath the charging platform, thus reducing the lengths of the blast pipes to the minimum. The blast pipes are so arranged that the cupolas can be operated individually or in pairs. The blast is generated by four positive pressure blowers, two having been installed by the Wilbraham-Green Blower Co., Philadelphia, and the other two by the P. H. & F. M. Roots Co., Connersville, Ind. Each blower is direct-connected to a 50-horsepower motor.

While the cupolas are still being charged by hand, two hydraulic charging machines are being built, each to serve two cupolas. The cupolas will be charged by the operator and only two men will be required on the charging floor instead of 12 at the present time. When the new machines are installed the charging buggies loaded with material will be transferred over tracks on the charging floor to a point directly in front of the cupola charging doors. It will then be raised by the hy-

FIG. 19—ANOTHER VIEW OF THE FOUNDRY

draulic plunger and the material will be charged directly into the cupola. The charges at present are made up in the yard and are elevated to the charging floor on a 2-cage electric elevator having a capacity of four tons.

Hot Metal Tramways.

Metal from the four cupolas is conveyed to the casting pits by two electrically operated overhead tramways, one serving casting pits 1 and 2, and the other pits 3 and 4. The controller for each trolley is placed on a pendant attached to the carriage of each traveler and moves with it from the cupola to the tables. The controller for conveying the metal is operated by the cupola tender, who starts the trolley with its ladle of iron to the casting pit, and the trolley is stopped by the workmen at the pit, thus eliminating one man who would otherwise be compelled to travel with the machine.

In a lean-to built at the east side of the main building and extending its entire length, with the exception of the breaks occasioned by the runways for the pipe sheds are the loam, sand and clay bins, which have a total length of 650 feet, are 23 feet wide and 13 feet high. The material used in the preparation of cores, and stored in these bins, is received over an elevated track 740 feet long which connects with the Scottdale connecting railroad, all material being unloaded from hopper bottom cars. Eight loam grinders or mud mills, shown in Fig. 5, are provided for the core department. The mills are of a new type and were especially designed for this plant. The four core-making machines located near the core ovens, are motor driven and produce two cores at each operation. Each core machine is served by two of the mud mills, and each of the 4 and 6-inch core machines is commanded by one 2-ton electric traveling crane. The 8-inch and 12-inch core machines are each served by one 3-ton electric traveling crane. The thirty-two coke fired ovens are distributed throughout the plant in four units of 8 ovens each, a section of the ovens being shown in Fig. 15. Each unit has a capacity for drying 150 12-inch cores or 450 4-inch cores. They are heated by furnaces of a special design and can be equipped for gas if desired.

Cleaning, Dipping and Testing.

The four pipe cleaning sheds are built at right angles to the east side of the main building at points directly opposite the revolving tables. Those extending from tables 1 and 4 are equipped with heating, dipping and testing appliances. At the end of pipe cleaning sheds 1 and 4 are located pipe drying ovens, dipping tanks, and the hydraulic testing houses. At the second revolving table the 175-foot shed is connected by a transfer with a shed from the first pit which conveys the pipe to the heating ovens and test house and from the third to the fourth revolving table there is a similar arrangement, but the layout is reversed. The pipe runways consist of 70-pound rails supported by cast iron columns resting on concrete piers. The tar tank in each of the long sheds is served by a 6-ton electric traveling hoist which is used for immersing the pipe in the dipping tank. After the coating has become hard the pipe is subjected to a proof by hydrostatic pressure at 300 pounds per square inch. High pressure pipe is sometimes tested to 500 pounds per square inch, but as the limit in size of the pipe produced by this plant is 12 inches, no high service pipe will be cast. The varnish in the dipping tank is heated to a temperature of 300 degrees Fahr., and this is maintained at this temperature during the time the casting is immersed. In addition each casting is heated to a temperature of 300 degrees Fahr., immediately before it is dipped. The ovens in which the pipes are heated are so arranged that all portions of the casting are heated to an even temperature, and each casting remains in the dipping tank at least five minutes. Pipe for gas mains is, however, not given this coating.

Compressor Plant.

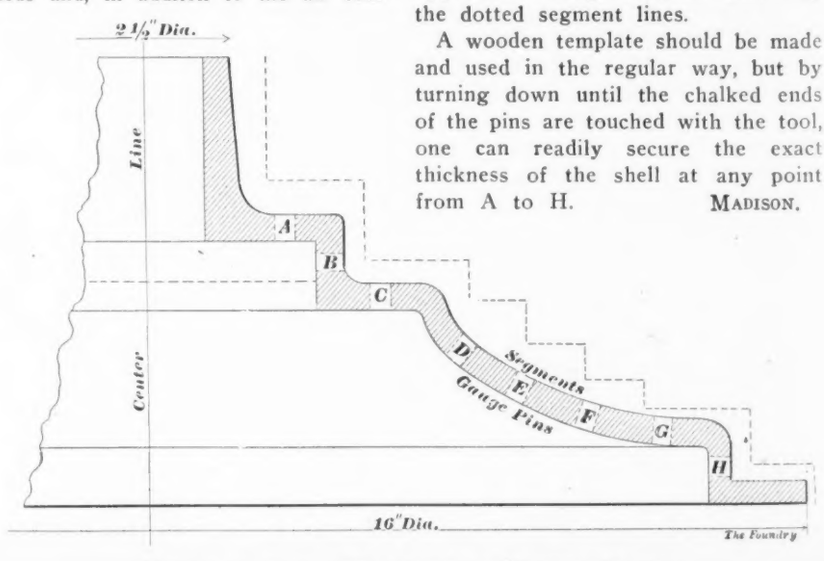
The compressor plant is located between the two short pipe cleaning sheds and, in additon to the air compressors contains the accumulators and hydraulic pumps. The compressors, which are equipped with Cutler-Hammer controllers, were installed by the Bury Compressor Co., Erie, Pa. The accumulators have a capacity of 600 pounds per square inch and each of the pumps is provided with an individual motor. The water tank adjoining the compressor house was built by the Riter-Conley Mfg. Co., Pittsburg, the tables having also been installed by this concern. The tank has a capacity for storing 15,000 gallons. The entire plant is electrically operated, power being furnished by the West Penn Electric Co. The entire equipment is driven by 65 motors, ranging in size from 1 to 100 horsepower, the total horsepower being 1,444.

METHOD OF GAGING THE THICKNESS OF PATTERNS.

The sketch of the half pattern in section presented herewith shows a simple and accurate method of gaging the thickness of patterns while turning. The sketch shows the inside finished and ready to reverse on a face plate. After removing the pattern from the face plate, quarter-inch holes are drilled all the way through on a radial line spaced at about ¾ to one inch at A, B, C, D, E, F, G. In other words, the metal from A to H is to be ¼ of an inch in thickness. Plugs are driven in the holes from A to H with glue until the ends are flush with the finished side. The opposite ends of the plugs are chalked with blue chalk before they are inserted in the holes. The pattern is then ready to rechuck for turning the opposite or rough side, as shown by the dotted segment lines.

A wooden template should be made and used in the regular way, but by turning down until the chalked ends of the pins are touched with the tool, one can readily secure the exact thickness of the shell at any point from A to H.

MADISON.

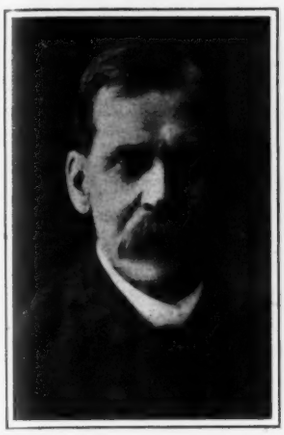


METHOD OF GAGING THICKNESS OF HOUSING PATTERN

FOUNDRY CUPOLA AND IRON MIXTURES*

A Discussion of Scientific Methods of Melting Iron—Calculating Mixtures

BY W. J. KEEP



IRON for ordinary castings is melted in a cupola, a vertical brick lined cylinder, in which are charged coke and iron in alternate layers, while air is forced in by a blower. The leading kinds of cupolas have the same general proportions which leave little room for improvement; by measuring a large number of cupolas, before any type had become common, and tabulating records of melting, the writer determined that proportions exert almost no influence upon the melting efficiency. The results depend rather upon the skill or care of the melter.

A special form of cupola is described in this article; but so far as details of construction are concerned, there are as many opinions as there are designers, and as good results are claimed with other forms.

It does not pay to purchase a small cupola. A 72-inch shell may be lined with red brick next to the shell and with fire brick inside to bring the inside diameter right—say 36 inches for a small business, to be increased as the business grows. Above the charging door the ordinary 5-inch lining may be used.

The Lining.

Every test the writer has made has shown that for ordinary melting of gray iron the cheapest stock brick may be used to good advantage. Square bricks should be used wherever possible, and key or arch bricks only when necessary to turn the circle without leaving spaces between. A stock brick, whether square, split, key or arched, will make as good a lining as the special shaped cupola blocks and is much cheaper. If the stock bricks are laid so that their surfaces touch each other and all spaces are filled with a thin grout, the lining will last as long as if made with large bricks.

In procuring brick care should be used in the selection of its size. If "square" or "straight" it should be 9 inches long, 4½ inches wide and 2½ inches thick (100 cu. in.). Good brick of these dimensions can be found at low prices. To produce a lower priced brick the size is often reduced to 8½ by 4½ inches by 2½ inches (90 cu. in.).

For special melting using steel scrap or for continuous melting, a more refractory (and expensive) brick may be needed.

In building up the lining the bricks should be dipped in a thin hot grout, made of one-third fire clay and two-thirds sharp sand, and laid tightly against each other, allowing the grout to fill all spaces. At intervals of two or three feet all the way to the top of the charging door rings of angle iron should be riveted to the shell to allow any section of brick to be renewed without disturbing the rest of the lining.

The lining above the charging door will last as long as the shell. The lining from the top of the charging door to the point at which the iron melts (herein termed the melting point) is not cut away by heat, although it is worn by the friction of the charges, and even when but 5 inches thick will often last several years. At the melting point it is often necessary to renew the linings every six months if the cupola is run to its full capacity. The bosh will need renewing about as often. The brick below the tuyeres becomes friable on account of the contact of fluid iron, but will last twice as long as that at the melting.

The usual lining is made of the same diameter up to the charging door, and as good melting can be done with such a lining as with any other shape. In the vicinity of the melting point, however, the lining gradually burns away, and it is customary to pick the slag from the surfaces and daub on a thick mortar composed of boiled fire clay and sharp sand, patching the holes with pieces of fire brick to bring back the original shape. But it will be found that the daubing is liable to shrink in drying out, and to fall off while the iron is melting. The accumulation of slag just below the melting point tends to build out the lining toward the center of the cupola into a shape that it will retain indefinitely—a sort of overhanging bosh.

Overhanging Bosh.

The construction herein described is to anticipate this natural action in the cupola by actually building the lining, in the first place, in the shape of this overhanging bosh. Make the lining 12 inches thick in the hearth; then form the overhang by making the lining 16 inches thick above the tuyeres; thence sloping back for the next 2 feet to the thickness of 5 inches opposite the melting point and the rest of the way up.

By this construction the blast is carried to the center of the cupola. The hot products of the combustion therefore do not cut away the lining opposite the melting point as they do with a straight lining; and the shell of the cupola opposite the 5-inch lining is no hotter than it would be with a straight lining 9 inches thick. The cupola can hold more iron and the melting is therefore more rapid; moreover, as the lining is thicker just below the bosh, less fuel is needed for the bed and the melting ratio is improved.

The Charging Door.

The usual height of the charging door above the bottom plate is 12 feet, but 15 or 17 feet is practicable. The more iron there is in the cupola the better, as it becomes heated by the waste gases before it reaches the melting point, and is thus brought nearer the melting temperature; even at 17 feet, however, the iron has not

* Presented at the annual meeting of the American Society of Mechanical Engineers.

become hot enough to melt by the time it gets to the melting point.

The charging door cannot advisedly be placed any higher, as the first charge would have too far to fall on the bed of coke. Moreover, at times when the bottom cuts through, or the blast apparatus is closed down, the bottom must be dropped when the cupola is full, and sometimes it is necessary to use a rod to make a hole through the slag that does not fall through when the bottom is dropped, which is inconvenient when the door is more than 17 feet above the bottom plate.

There is no need of a tight charging door. A wire screen let down in front of the opening when the last charge is in will keep sparks from blowing out.

The Tuyeres.

The distance of the tuyeres from the cupola bottom depends upon whether anthracite coal or coke is used, and upon the kind of castings made. In using coke, where the iron runs out as fast as melted, the distance from the bottom of the tuyeres to the sand bottom should be about 12 inches. For machinery castings the distance should be such that the iron can accumulate without running out of the tuyeres.

The shape or number of the tuyeres is not of great importance, but the usual construction is of cast iron, bolted to the shell, and of a size to admit enough air to burn the coke in the shortest possible time. The admission of air depends on the friction in the blast pipes at the tuyere openings and the blast pressure at the tuyere, and the size should be calculated for about eight ounces pressure.

It is usual to keep the top and bottom tuyere walls nearly horizontal. The sides, however, should be flared toward the center of the cupola to compensate for the partial choking of the admission of air by the fuel and chilled slag lying directly in front of the tuyeres. The overhanging bosh, described above, helps to form a continuous air chamber and prevents clogging, by melted iron and slag, all around the cupola in front of the tuyeres, thereby insuring a gentle and even admission of the blast that does not injure the lining. By giving a slight inward flare to the openings, the tuyere casting can be made with a green-sand core, but they may be made so wide at the inner end that they nearly or quite touch each other. One or more supports are cast near the inner openings to prevent the top of the tuyere from sagging. The shape must be such, however, that when melted iron accidentally rises and chills, it can be pushed out without injury to the tuyere.

A very good way to form a practically continuous tuyere is by means of plates or segments 1 inch thick, and equal in width to the thickness of the lining at the tuyere circle. When the lining is built to within an inch of the blast openings in the shell, a circle of the segments is laid on it. Cast iron blocks 3 inches wide and 4½ inches high are placed on the shell even with the front of the circle and about 7 inches apart. Another circle of segments is laid upon these blocks and then the regular brick lining is continued. This construction leaves a 3-inch continuous space unbroken by partitions, next to the shell, and permits the air to enter at all points with equal force.

The Bottom.

The bottom is made of sifted sand from the gangway, dampened, tempered and riddled. The sand should be shoveled in through the breast and stamped with the feet, and then rammed as in molding. Make a close joint around the edges, and have the sand at least 2½ inches thick above the cupola bottom at the level of the spout lining (not the bottom doors) and with a level and straight edge make it slope up toward the back ½ inch in each foot.

If the bottom is too wet, or is rammed too hard, it is liable to lift up and crack and let the melted iron cut through the bottom doors. To prevent this, drill the doors with ½-inch holes 4 inches apart, so that the steam and gases from the sand bottom can escape.

The Breast and Tap Hole.

To make the breast, hold a board against the inside of the cupola and ram from the front a mixture of one-third part fire clay, and two-thirds burnt molding sand wet with clay-wash and tempered with new sand.

Form the tap hole with a smooth stick, 15 inches long and tapering from a diameter of 2 inches at one end to 1 inch at the other, laid in the breast with its small end against the board. When the breast is rammed full, remove the board, shove the stick in 2 inches and scrape away the breast at the front to an arch until at the top hole it is only 1 inch thick.

Charging and Running.

In a 72-inch cupola use about four bushels of shavings, and spread some over the bottom and pile them up around the sides to the tuyeres in front of which lay shavings and splinters. Then lay kindlings evenly over the whole bottom and set soft cord wood on end all around the sides, with some short pieces in the center.

For the bed charge 1,200 pounds of coke, and light the fire at the tuyeres and at the tap hole two hours before the wind is to be put on. Build a wood fire all along the spout (which has been lined 1 inch thick with the same mixture as the breast) and light the fire in front of the breast, leaving the tuyeres and tap hole open until the coke is well ignited. After the wood is all burned out, close the tuyere doors and charge on 500 pounds coke. Bend the ends of a rod, at right angles, in opposite directions, of such length that when the upper end hangs on the charging door sill, the lower end will be two feet above the top of the tuyeres. Add enough coke to reach up to the lower end of the rod, and spread evenly on this coke one-half of the first charge of pig iron and scrap, and 100 pounds of coke, then add the other half charge of iron. This makes 1,800 pounds of coke on the bed, and 4,800 pounds of iron consisting of 3,200 pounds of pig iron and 1,600 pounds of sprues and scrap (for stove plate). All the rest of the charges consist of 250 pounds of coke and 3,000 pounds of iron.

Scatter over each charge of coke two shovelfuls of screenings from the gangways, and two of limestone, broken as small as an egg. Continue charging until full to the charging door. If the fire is lighted at 12 M. the charging should begin at 12:30 P. M., and the wind put on at 2 P. M. Stop the tap hole at 2:10, and tap out at 2:15. With 20 charges (31 tons) the wind should be off at 5 P. M. Fuel ratio 9 to 1, and the melting 10 tons per hour. (Cupola 72-inch shell).

The Blast.

Fast melting fuel must be burned rapidly. With free entrance for air and with a positive blower the speed of melting can be increased by increasing the blast up to 18 ounces pressure. No further increase of speed in melting is obtained with 22 ounces pressure and with 26 ounces the melting will be slower, showing that more air is blown than can be used. About 14 ounces is the best pressure for any kind of blower or cupola. When speed is not required, a lower pressure (perhaps six or eight ounces) may give more economical results.

As good results are obtained with one kind of blower as with another. Those who use a positive blower think they get a stronger blast, but it does not pay to change if the blower already in use is large enough.

Advantages of Hot Iron.

Iron should be melted hot, whether it is to be poured hot or dull. Hot iron is fluid, and gases and slag can separate and castings will be even in grain and free from blow holes.

It is important to have a hot cupola before the iron begins to melt. Whether the cupola is small or large, the fire should be lighted two hours before the iron is needed, and the fuel should be well lighted all over the center before the iron is charged.

Slagging.

Slag should be drawn off and not allowed to reach the tuyeres. The slag hole is a 4-inch square hole left in the brick lining opposite the tap hole with its top about 4 inches below the bottom of the tuyeres. It is lined and its upper end is stopped with daubing clay. Slag should be allowed to accumulate until it is nearly up to the tuyeres as it protects the melted iron from the blast and strains out the dirt. Before the slag runs out of the tuyeres the slag hole is opened just enough to let the slag run as fast as it forms. By arranging a trough, a crust will form, covering the hot stream beneath, and by raising the crust a little with a bar it will set and form a channel which will keep a steady stream of slag flowing with no noise or escape of wind.

Saving Iron From the Bottom.

A way to save iron dropped from the bottom of the cupola is as follows: After the wind is off and all melted iron has run out of the cupola, make a circular dam of sand about 4 feet in diameter in front of the cupola and about 4 inches high. Lay a tapping bar across the spout and with a piece of 1½-inch shafting 8 feet long ram in the breast and let all of the slag run out on the floor. The iron will settle under the slag. When the slag is all out, drop the bottom, wet it down and draw it out. In the morning, there being no slag, the bottom can be picked over by hand. All iron is thrown to one side, and any piece of sand bottom, or of slag not containing iron, is discarded. All coke large enough to use is saved; and all small coke and iron is shoveled up and taken to the scaffold, to be thrown in, with all skulls and sweepings containing iron, when the last charge has settled some distance down. The small coke holds down the blast, improving the last melting, and drops again with the bottom. The cupola is so hot that this iron is fit for use for almost any casting.

Fuel Ratio.

For heavy machinery castings and car wheels, with large cupolas, and when the iron need not be as hot as for small castings sometimes 18 pounds of iron are melted with 1 pound of coke, counting in the bed and not deducting iron or coke dropped with the bottom. For ordinary castings it is not economical to run any risk of having dull iron, because the loss of castings would be greater than any saving of coke.

For stove castings, for which the iron must be as hot as for any work, a fuel ratio of 9 to 1 can be maintained constantly with a 72-inch cupola, using a coke bed of 1,800 pounds and melting 30 tons in 2¾ hours. To obtain such a ratio it is not necessary to break the pig iron, but all scrap should be broken as small as the pig iron, so as not to leave voids. The coke, pig and scrap must be charged uniformly. It is better to charge one row of pig iron flatwise around the circumference, then another row inside of this, and so on until the center is filled. One ton of pig iron will make about one thickness all over.

Stove plate, sprues and scrap weighing half a ton will take more room than the pig iron and 260 pounds of coke will completely cover the iron charge. The charge for stove plate will be 250 pounds of coke, 1,950 pounds of pig and 1,600 pounds of scrap, and the regular charge of 3,000 pounds of iron and 260 pounds of coke then continues through the heat.

Greater economy can be obtained if the coke is reduced on the last three charges, and sometimes the cupola will be so hot that the last charge can be melted with very little coke. The smaller the coke charge the faster the melting, provided sufficient coke is used to melt the iron hot. For fast melting, care and cleanliness are essential; no dirt or dust from the charging platform must be shoveled into the cupola, as it will prevent the iron from setting evenly.

Quality of the Coke.

The quality of the coke is one of the most important things in iron melting, because the iron is in constant contact with the fuel. Coke should contain about 10 per cent of ash so as not to crush by the weight of the iron, or break up by the heat. If it contains too much volatile matter it will melt and clog the cupola, but the percentage of volatile in good and bad coke varies so little that it cannot be determined by analysis.

The sulphur should not exceed 0.75 per cent, but very often amounts to 1 per cent and over. It is estimated that with 0.75 per cent of sulphur in the coke 0.03 per cent will enter the casting; and as the sprues and bad castings are remelted each day it is difficult to keep the sulphur in the castings below 0.08 per cent, which is the limit. In machinery scrap and stove plate scrap sulphur is estimated at 0.08 per cent. Therefore if the coke contains more than 0.75 per cent of sulphur it is very difficult to use scrap enough to give a close grain without exceeding the above limit and thereby causing hard spots and blow holes in the casting.

Since the great demand by blast furnaces for beehive oven coke, it has not been as reliable as when the founder could refuse a carload which did not give good results. Retort oven coke can be made of uniform quality and it is very satisfactory, but does not look as well as beehive coke.

The Flux.

Limestone is the best flux, and in a slight degree lessens sulphur; but its chief use is to make the slag fluid enough to run out of the slag hole, and to keep the cupola clean, especially when the bottom is dropped.

It is a question whether the special fluxes on the market do as much good as claimed, but they are worth a trial. Fluor spar is more efficient than limestone, but is more expensive.

Iron Mixtures.

It is physical quality that the founder requires, and he would not trouble himself about the chemical composition were it not that by varying it he can vary the physical quality to some extent.

By decreasing sulphur, or by increasing silicon, the casting will be made softer. By decreasing sulphur, or by increasing silicon, or phosphorus, or both, fluidity is increased, and the iron is grayer and has less shrinkage. By increasing the manganese the sulphur is decreased or rendered less harmful.

But the physical quality of the iron charged, the conditions under which the iron is melted and the manipulation of the fluid iron also materially influence the physical quality of the

casting, irrespective of the chemical composition.

Pig Iron.

Close grained and strong pig iron is likely to make castings having those characteristics. The close grain is generally accompanied by low silicon and sometimes by high sulphur, but it may have been caused by the original smelting conditions, i. e., whether the blast furnace was cold or hot. Close grain in a soft casting generally means that it is strong, but for the closest grain and the greatest strength the casting is generally as hard as can be tooled.

Another reason for using close-grained, low-silicon pig irons, and pig-irons low in phosphorus, is that they set more quickly, thereby preventing internal shrinkage and porosity. Large castings cool slowly; the interior is fluid a long time after the exterior has become solid, and contracts more and more as its temperature lowers, so that when its center reaches the freezing point there is not enough bulk to fill the space. In solidfying it crystallizes on the crystals already formed, resulting in a very loose grain at the center; and finally, as the last iron becomes solid, a true cavity is left. Thus we have a shrink hole surrounded by a spongy iron. By feeding hot fluid iron to such a center through a channel which is kept open by churning with an iron rod, every part of the casting can be made solid.

By using northern irons made from Lake Superior ores the tendency to sponginess is lessened because they set quicker than southern irons. Or if an iron chill can be placed in the mold in a wall very near the spot that would otherwise be spongy it will set the metal quickly and prevent the trouble.

The Scrap.

Castings made from scrap iron of the same general size and grain as is desired in the casting and cast under practically the same conditions may be expected to have a similar grain—or a tendency toward a closer grain which would require to be offset by the addition of a small amount of a more open pig iron.

An unduly coarse grain in the scrap will close up somewhat in remelting or close-grain pig iron may be used with it. Small, close-grained scrap, remelted for making a large casting which cools slowly, having a relatively higher silicon, will have a coarser grain.

Scrap is not ordinarily analyzed, though it often constitutes one-half the total mixture. Silicon runs 1.50, 2.00 and 2.40 per cent in heavy, medium, and small soft scrap, respectively, and the sulphur is about 0.08 per cent.

In selecting scrap for a mixture, throw out all wrought, burnt, malleable and chilled iron, and all steel.

Stove plate scrap is very close grained, with sulphur about 0.08 per cent and silicon about 2.75 per cent. For machine castings it closes the grain and adds strength, but its silicon is not as effective as in pig iron because of its high sulphur and rather low carbon. The loss in weight during melting is excessive.

Select machinery scrap the size of the castings to be made, and break it small enough to melt in the cupola as fast as the pig iron.

Following are chemical compositions and physical qualities desirable in iron for various kinds of work, and some mixtures that will give them.

Hard Iron for Heavy Work.

Castings for compressor cylinders, valves, high pressure work, etc.

Chemical composition: Silicon, 1.20 to 1.50 per cent; sulphur under 0.09 per cent phosphorus 0.35 to 0.60 per cent; manganese 0.50 to 0.80 per cent.

Physical qualities: Transverse strength of a test bar 1 inch square and 12 inches long, 2,400 to 2,600 pounds; tensile strength of same bar 22,000 to 25,000 pounds; shrinkage in yokes, 0.160 inch; chill in yokes, 0.25 inch.

Mixtures: Steel scrap to the amount of 10 to 25 per cent may be added in the cupola. In a foundry running both air furnaces and cupolas, for castings of over 15 tons, one-half of iron from each may be mixed in the ladle to give strength. When the amount of steel exceeds 10 per cent a very small quantity of aluminum should be used in the ladle to increase fluidity. It will remove all gases, prevent blow holes, and give a very close grain. A piece of pure aluminum wire ⅜-inch in diameter, and 1 inch long, for each 100 pounds of iron, is sufficient; do not use so called "casting aluminum." To insure a perfectly sound interior, make large castings as hard as will allow of machining, by keeping the silicon as low as possible. Select close-grained foundry iron low in silicon, or mill iron if the grain of the foundry grade is too coarse. A close grain in pig iron accompanies a higher sulphur content which is due to a cold furnace. Charcoal pig iron gives a close grain with low sulphur.

Although using scrap closes the grain, use it sparingly for the strongest castings—sometimes not more than 10 per cent, to avoid introducing sulphur. It is safer to use close-grained pig, and steel scrap. For extra strength, use 1 to 10 pounds of ferromanganese, either in lumps in the cupola or granulated in the ladle.

The best way to close the grain and prevent sponginess is to charge 100 pounds of cast iron borings with each ton of the mixture packed solid in a covered wooden box 6 inches deep. The box settles down to the melting point before the wood burns, and then the borings melt and mix, without more than 10 per cent loss. Steel borings and chips can be used instead, but aluminum is needed in the ladle. Do not mix cast iron and steel borings in the same box.

In calculating mixtures for heavy castings, allow 1.50 per cent silicon and 0.10 per cent sulphur to be contained in the scrap.

Medium Iron For General Work.

Castings for low pressure cylinders, gears and pinions, etc.

Chemical composition: Silicon, 1.50 to 2.00 per cent; sulphur, under 0.08 per cent; phosphorus, 0.35 to 0.60 per cent; manganese, 0.50 to 0.80 per cent.

Physical qualities: Transverse strength of a test bar 1 inch square and 12 inches long, 2,200 to 2,400 pounds; tensile strength, 20,000 to 23,000 pounds; shrinkage 0.154 inch; chill 0.15 inch.

Mixtures: Nos. 1, 2 and 3 foundry iron. Home and foreign scrap up to 50 per cent of the whole is allowable for the best castings; or more with carefully selected scrap. In calculating mixtures, allow 1.75 to 2.00 per cent silicon and 0.10 per cent sulphur in foreign scrap.

Soft Iron.

For general car and railway castings, pulleys, small castings, and agricultural work.

Chemical composition: Silicon 2.20 to 2.80 per cent (with less the castings are hard, and with more they are too weak). For large castings, 2.40 per cent is a good average; sulphur under 0.85; phosphorus under 0.70; manganese under 0.70.

Physical qualities: Transverse strength of a test bar 1 inch square by 12 inches long, 2,000 to 2,200 pounds; tensile strength, 18,000 to 20,000 pounds; texture: To close the grain use as high a percentage of scrap as will give soft castings.

Iron For Frictional Wear.

Castings for brake shoes, friction clutches, etc.

Chemical composition: Silicon 2.00 to 2.50 per cent; sulphur under 0.15 per cent; phosphorus under 0.70 per cent; manganese under 0.70 per cent. The addition of spiegeleisen increases hardness.

Calculating the Composition of An Iron Mixture.

A variation in silicon will make castings either hard or porous. The grain of the pig and the fracture of scrap are generally reproduced in the casting. The seller of pig iron will give a close approximation to the chemical composition of his iron. The ordinary founder will not employ a chemist to make exact determinations.

Whether the founder uses the approximate or the accurate determination of his irons, he should calculate the chemical composition of his mixture.

Approximate Calculation.

Make up on paper the desired mixture, using irons in stock and figure from the analysis, or estimate, of each pig iron, the previously calculated composition of the home scrap, and the estimated composition of the foreign scrap. Multiply the pounds of each iron used by its percentage of silicon to obtain the pounds of silicon, and divide the aggregate weight of silicon in all the irons by the total weight of iron used, thus obtaining the percentage of silicon in the mixture. Deduct 0.20 per cent for loss in melting. The remainder is the silicon in the casting; and if this is too high or too low to produce the desired percentage, vary the irons and figure again; and so on until you secure a mixture that will be satisfactory.

Precise Calculation.

To arrive at the composition by one calculation: If you are forced to use certain irons, determine their weights by considerations of economy, or of stock on hand (for example, enough home scrap to prevent accumulation; enough foreign scrap to cheapen the mixture or to close the grain, and the desired pig irons) and compute the total silicon as before. Then adjust the percentage of silicon in the mixture by calculation from two pig irons, one lower and the other higher in silicon than the percentage just computed, as shown in the following example.

An actual stove plate mixture was desired having 3.50 per cent silicon in a charge of 3,000 pounds. The chemist's analysis card had accompanied each car of pig iron. In this case no foreign scrap was used.

	Weight in pounds.		Per cent Silicon.		Pounds Silicon.
Home scrap	900	×	3.25	=	29.25
No. 1 foundry	400	×	2.50	=	10.00
No. 2 foundry	350	×	2.18	=	7.63
No. 3 foundry	250	×	1.53	=	3.82
	1,900				50.70
	3,000	×	3.50	=	105.00
Needed	1,100	×	4.94	=	54.30

That is, we needed 1,100 pounds of an iron having 4.94 per cent silicon to balance the mixture.

We had in stock No. 1 soft with 2.95 per cent silicon, and Ashland silvery with 7.00 per cent silicon; which balanced for the 4.94 per cent as follows:

	Differences.	Balances.	Total Parts.
4.94 No. 1 soft 295	—199	206	405
Ashland silvery.7.00	+2.06	199	

1,100 ÷ 4.05 = 2.72 pounds = 1 part.
206 × 2.72 = 560 pounds of No. 1 soft needed.
199 × 2.72 = 541 pounds of Ashland needed.
Take 550 pounds of each to make even weights.

This example will fit almost any foundry condition. The result can be checked by computing the silicon in each iron as follows:

550 × 2.95 = 16.225
550 × 7.00 = 38.50
1,900 = 50.70

3,000 × 3.51 = 105.42

Allowing loss of silicon 0.20 gives 3.31 per cent silicon in the casting. The actual analysis was 3.34.

If, on the other hand, you have plenty of each of the irons in stock and do not care what proportions you use, calculate as follows:

	Differences.	Balances.	Total Parts.	Total parts.
Home scrap 3.25	—0.25	350	350	
No. 1 foundry 2.50	—1.00	350	350	
No. 2 foundry 2.18	—1.32	350	350	2,250
No. 3 foundry 1.53	—1.97	350	350	
No. 1 soft 2.95	—0.55	350	350	
Silvery 7.00	+3.50	25 + 100 + 132 + 197 + 55	509	

3,000 pounds = 2,259 parts. 1 part = 1.328 pound.

Iron.	Parts.	Weight.
Home scrap	350	464.8 pounds
No. 1 foundry	350	464.8 pounds
No. 2 foundry	350	464.8 pounds
No. 3 foundry	350	464.8 pounds
No. 1 soft	350	464.8 pounds
Silvery	509	676.0 pounds
Total		3,000.0 pounds

But you can only weigh differences of 50 pounds, so divide the 3,000 into multiples of 50. If you wish to do so, use 650 pounds of home scrap.

Proof.
650 × 3.25 = 21.125
450 × 2.50 = 11.25
450 × 2.18 = 9.81
450 × 1.53 = 6.88
450 × 2.95 = 13.28
650 × 7.00 = 45.50

3,000 × 3.59 = 107.84

Loss of Iron.

The following is the only reliable published data on remelting losses of which the author knows:

In a cupola lined to 52 inches one ton each of several different irons were melted at one time with the results given below. No iron was thrown away, and the data are reliable.

Kind of Iron.	Pounds loss per ton.	Per cent.
A No. 1 Cherry Valley Pig (Si. 2.70 per cent S. 0.015 per cent	95	4.75
B Cleaned new stove plate.....	159	7.95
C Cleaned sprues from stove plate	130	6.50
D New stove plate with sand on.	230	11.50
E New sprues plate with sand on	280	14.00
F Old stove plate scrap (rusty).	227	11.35

By pickling with hydrofluoric acid it was found that 33 pounds of the 95 pounds loss of A was sand purchased on the pigs. Milling a ton of F just as purchased showed that 50 pounds of the 227 pounds loss was rust.

Taking results from A to F:

	Loss pounds per ton.	Per cent.
The calculated loss from a 37-ton heat (72-inch cupola).....	116	5.80
The actual loss from a 37-ton heat (72-inch cupola).....	88	4.41

In a small cupola with small heats the loss would be relatively greater.

MEMORANDA FROM THE 37-TON HEAT 72-INCH CUPOLA.

Shot iron recovered from the gangway.. 26 pounds per ton melted
Good sand recovered from the gangway..411 pounds per ton melted
Coke recovered from the bottom ..... 57 pounds per ton melted
Slag tapped out.....207 pounds per ton melted
Sand on pig from pig bed ..... 30 pounds per ton melted
Limestone used as flux 43 pounds per ton melted

TEST BARS ½-INCH DIAMETER BY 12 FEET LONG.

	Strength.	Shrinkage.
37-ton heat stove plate.	380 pounds	0.149 inches
Remelted cleaned stove plate	390 pounds	0.162 inches
Remelted cleaned plate sprues	375 pounds	0.158 inches
Remelted old stove-plate scrap	377 pounds	0.202 inches
Remelted No. 1 Cherry Valley Pig	410 pounds	0.149 inches

In large stove foundries the sprues and plate lost in pouring are charged into the cupola with sand on, it being cheaper to melt the sand than to mill it off; hence the large amount of slag. In machine foundries the gates and lost castings being more bulky, the loss in remelting would be less than in a stove foundry.

Boiling of the first iron on the cupola bottom and in the green ladles is likely to form a white core and gray surface in the first castings; therefore pour unimportant work with the first 500 pounds.

Loss of Other Constituents.

By remelting, carbon is very rarely increased, and is generally decreased; more of it is in combined form than before because the cupola is not as hot as the blast furnace, and because the sulphur is increased.

Silicon decreases about 0.20 per cent; phosphorus remains constant; and manganese decreases about 0.15 per cent; when in the casting it is 0.50 per cent.

By using percentages of sulphur, phosphorus and manganese as in the proof, we can find the percentages of these elements in the casting. The object of varying the chemical composition is to control the shrinkage, hardness and grain of the casting, and we must test these physical qualities to ascertain the result of the chemical variation.

For the mixture first calculated, a test bar ½-inch square by 12 inches long gave a strength of 430 pounds; shrinkage 0.126; chill 0.06, and hardness 23 degrees.

The analysis was: Total carbon 3.43, graphitic carbon 3.27, combined carbon 0.16, silicon 3.15, phosphorus 0.958, sulphur 0.055 per cent.

Mechanical Analysis.

Turning the above the other way, we find that a shrinkage of 0.126 resulted from 3.15 per cent silicon. We also know that a decrease of silicon increases shrinkage and vice versa; therefore, if the shrinkage rises above 0.126, we must increase the silicon by using more of some iron high in silicon to bring it back, and if it drops below 0.126 we can use more scrap or hard irons, thereby decreasing the silicon and cheapening the mixture.

This regulating the silicon from the physical end is a mechanical analysis; and it is the only one, since shrinkage is the only physical quality that varies with a variation of silicon. Mechanical analysis is quick and inexpensive. It can be used by any founder and goes directly to the spot without any chance of mistake.

RUMBLING CASTINGS

BY PAUL R. RAMP

THE ADVANTAGES of the rumbler in the foundry are many. It is possible to use cheaper iron in the mixture if the castings are thoroughly cleaned in a rumbler, because the surfaces of the castings are free from sand and it is possible to make a smooth job without using an excessive amount of sea coal facing and blacking. Sea coal facings have a tendency to create a harder scale on castings.

In making such tests, an analysis of drilling from the surface of the casting must be made, and another of drillings from the center of the casting. If the analysis of the surface drillings shows a higher sulphur than the center drillings, it is safe to assume that the iron has absorbed sulphur from the material of which the mold is composed.

Use of Facing.

Castings such as cylinders, engine frames, bearing plates, etc., that can be placed in a large rumbler should be molded with a light sea coal facing consisting of seven parts new molding sand, and one part of sea coal. This facing should be used next to the pattern in ramming up the mold, and would be sufficient to prevent the mold from scabbing. While the appearance of this casting when taken out of the sand would not be as smooth as when a stronger facing and a heavy coat of lead was used, it is quite probable that the machinist would have less trouble getting under the scale, as one hour in a good rumbler 40 inches in diameter running 28 revolutions per minute, would make a smoother casting than one that was made with a heavy facing and not rumbled.

Aside from the advantage the machinist enjoys in working up rumbled castings, the chipping cost is greatly reduced, as all the fins and all the seams are knocked off in rumbling, and the labor required to dig out cores obviated.

Saving of Labor.

The molding room is also benefited, as it is possible to save all the labor required in applying plumbago to the surface of the mold. The rumbler also affects the loss of bad castings. Hot iron is a strict essential to the production of clean castings, and castings that are subjected to a high pressure of air, steam or water. While hot iron will make clean work, it will cause the sand to fuse and adhere to the castings to such an extent that nothing short of a rumbler or sand blast will remove it. I prefer the rumbler where castings are not too large, because it will make them more smooth.

I do not desire to convey the idea that I consider facings unnecessary, but I know that a great deal of the molder's time is often wasted in daubing his mold with blacking, and slicking it to death, the latter being more injurious than beneficial.

In applying plumbago to the surface of molds for small castings the sharp corners are often filled which results in an imperfect casting as far as the true outline of the pattern is concerned.

Location of Rumblers.

Rumblers should be placed in a foundry with a view to economy in handling the castings. A good plan is to place them in a row, about 2 feet back of the chipping bench, and 8 feet from the wall. The 8-foot space will be sufficient to run a narrow gage track for the delivery of the castings, and also storage space for the balance that cannot be rumbled at once. When this arrangement is used, the castings can be loaded into the rumbler from the track side, and the rumbler unloaded on the chipping bench from the bench side. It also permits of the removal of refuse without interfering with the chipper.

Two men should be able to keep at least six 36-inch rumblers going steadily, loading rumbler No. 1, and starting it, then loading No. 2 and starting it, and so on until No. 6 is loaded; by the time No. 6 is loaded it will be time to unload and reload No. 1 and No. 2, and as many of the balance necessary to clean all the castings made.

In cases where the rumblers are operated in batteries of two or more, it is impossible to start one mill until they are all loaded, and then the men are compelled to wait until the castings are rumbled in every mill before they can accomplish any more work.

VANADIUM AND AUTO CYLINDERS.

One of the most serious features of deterioration in cars is the loss of compression through the wearing of the cylinders. Foreign engine castings always have been superior to any American product in this respect, but few have understood why. Light has been thrown on the subject recently by some experiments made by the American Locomotive Automobile Co. It was found that the inside of the cylinder castings obtained here will take a polish from the piston action quite readily, but that very soon after the inside polish has reached its best, it begins to check and crack away, leaving roughness. To this is due the loss of compression. Some imported Berliet cylinders, tried under the same conditions, took higher polish and held it, the compression showing no loss after long service. The fact that the Berliet castings have a considerable percentage of vanadium is believed to partly explain the difference.—*Graphite.*

PATTERNS FOR REPETITION WORK—I*

Construction of Patterns That are to be Used Continuously in the Foundry

BY E. H. BERRY

A PATTERN which is run continuously for months, or perhaps years, clearly falls within the limits of this paper as being used for repetition work. And it is just as clear that one which is discarded after a single casting has been made from it should be classed as a pattern for jobbing work.

The exact point which marks the division between them depends, in a large measure, upon the size of the foundry and the kind of work it handles, and the two classes frequently merge into each other by imperceptible gradations. Without attempting to fix specific limits, we can use the extreme cases cited above to indicate the lines along which the distinction should be drawn, leaving each pattern user to decide for himself as to the precise position on the scale which he assigns to any given pattern.

It is this position which usually determines the expenditure that can be permitted in making the pattern, for it is evident that a cost which would be perfectly legitimate for making, say, 1,000,000 castings, might be excessive if only 10,000 were required, and entirely prohibitive for 1,000. On the other hand, the circumstances might be such as to justify a high pattern cost, even for a small number of castings, as for instance, in the case of certain master patterns, further reference to which will be made elsewhere in this article.

*Presented at the annual meeting of the American Society of Mechanical Engineers.

Jobbing Patterns.

Many of the conclusions reached in this paper may be borne in mind to good advantage even in the case of jobbing patterns. But the very nature of the service for which these are intended is such that the designer must leave most of the details to the judgment of the patternmaker; and if the latter fails to catch every important point, it simply means that the molder may have to spend some additional time in producing the desired casting from the pattern furnished him.

Actual observation of the practical working of different methods of producing patterns has convinced the writer that no pattern which can be legitimately classed as being used for repetition work should ever be made except from a drawing which looks like the pattern, and gives the actual dimensions of the pattern itself. Mention is made of the fact that the drawing should look like the pattern, for the reason that, on small work, the allowances for shrinkage, finish and draft may make the appearance of the pattern quite different from that of the finished piece.

Accuracy.

In making patterns for repetition work, micrometer calipers, vernier calipers, height gages, etc., are constantly called into requisition, and as it would be both expensive and confusing to attempt to duplicate these in different shrinkage scales, it becomes necessary to work to figures which include the necessary allowances for shrinkage. To the man who is accustomed to big work on which a quarter of an inch is close, and a thirty-second is the very height of refinement, it may seem absurd to use thousandths in measuring patterns. But there are many cases in repetition work where this degree of accuracy is not only desirable but absolutely essential.

As an example of the effects of shrinkage and finish, let us assume that we wish to produce the piece shown in the upper part of Fig. 1, the marks *f* indicating finished surfaces.

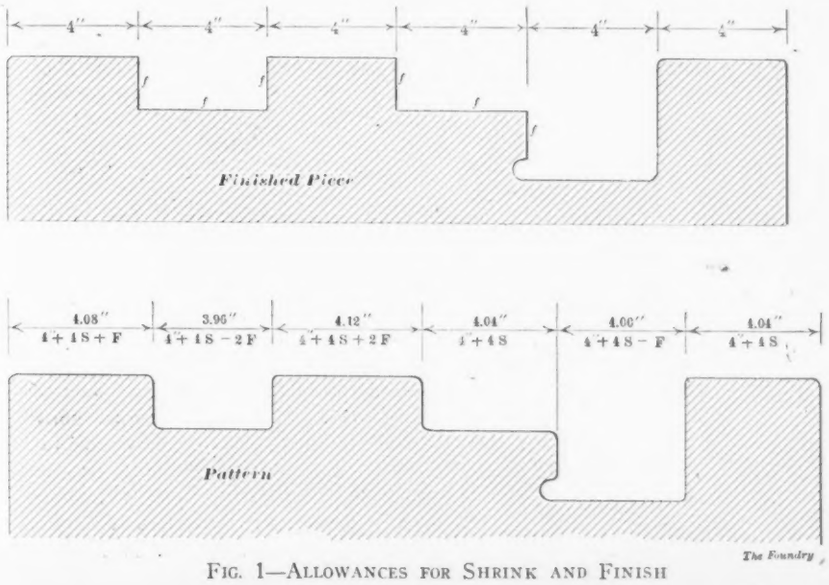


FIG. 1—ALLOWANCES FOR SHRINK AND FINISH

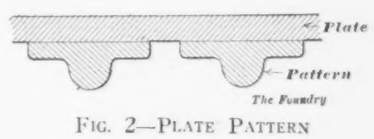


FIG. 2—PLATE PATTERN

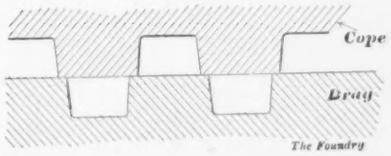


FIG. 3—CASTINGS STAGGERED IN DRAG AND COPE

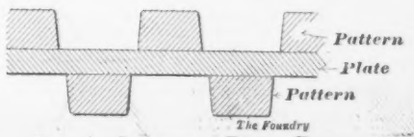


FIG. 4—STAGGERED PLATE PATTERN

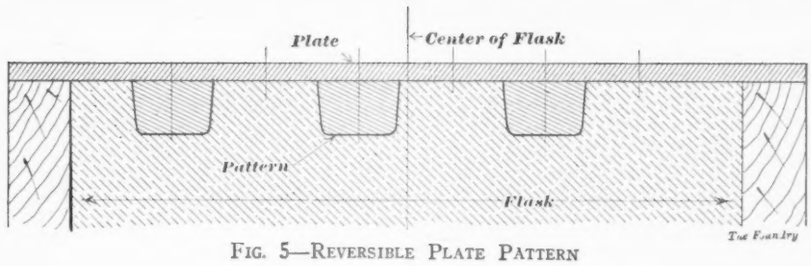


FIG. 5—REVERSIBLE PLATE PATTERN

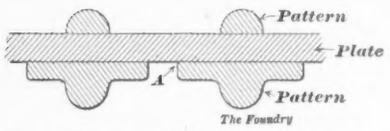


FIG. 6—PLATE PATTERN WITH PORTIONS OF PATTERN ON EACH SIDE OF PLATE

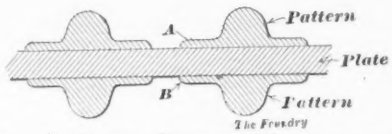


FIG. 7—PLATE PATTERN CALLING FOR ACCURATE MATCHING OF DRAG AND COPE

The lower part of Fig. 1 shows the actual pattern dimensions, assuming,

Shrinkage per inch of length, S = 0.01 inch
Allowance for finish, F = 0.04 inch

In this particular case, the various combinations of shrinkage and finish modify the final 4 inch dimensions so as to produce dimensions of 3.96 inches, 4.00 inches, 4.04 inches, 4.08 inches and 4.12 inches on the pattern.

In actual practice, the dimensions would not usually be strung out in one continuous line as in Fig. 1, but would probably double back on themselves to some extent. In addition the shape of the casting might be such as to make the shrinkage irregular; it might be desirable to allow more finish at certain surfaces than at others, and it might be necessary to make additional allowances for draft.

In view of all the factors to be considered, the determination of the pattern dimensions by a process of mental arithmetic may be an excellent athletic exercise for the brain, but it is not a problem which a mechanic should be called upon to solve during working hours.

It is also necessary to remember that very few machinists or tool makers have much detailed knowledge of foundry practice, and that the trade of metal patternmaking is still comparatively new. Patterns made and carded according to the best judgment of a tool maker have often been entirely rebuilt after the first attempt to run them in the foundry. Of course such occurrences indicate lack of co-operation, but the only practical way to secure effective co-operation is to prepare a drawing which records the decision reached after due consideration by all the interested parties.

There is no doubt but that the best and most economical results are obtained by using men who are skilled in working accurately to drawings, and then supplying them with drawings which they can follow absolutely. If a pattern has to be duplicated or replaced, the worn one must either be copied as closely as possible, or the workman, who may or may not be the author of the original pattern, must introduce a new set of allowances.

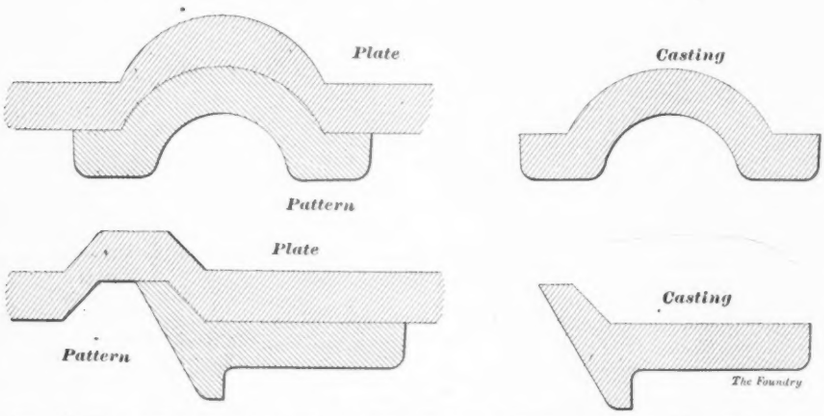


FIG. 9—PLATE PATTERNS IN WHICH THE PARTING SURFACES ARE NOT PLANE

Shrinkage.

For computing shrinkages, the drawing room should be furnished with a table giving the shrinkage per inch (in hundredths or thousandths of an inch) for each of the materials commonly used. This shrinkage, multiplied by the length in inches of any part of the casting, gives the allowance in inches direct. It may seem superfluous to explain this apparently self-evident procedure, but the author has seen cases in which the shrinkage was expressed in fractions of an inch per foot of length and in which each dimension was carefully translated into decimals of a foot before multiplying by the constant.

It will frequently happen that there are certain parts of a casting where a high degree of accuracy is not necessary, and a very little time spent by the drawing room in determining and indicating these points will be amply repaid by the saving in making the patterns. The required degree of accuracy can best be indicated by means of the number of decimal places in the figure giving the dimension. In using this method there must be an understanding between the drawing room and patternmaker that the permissible error is never greater than one in the last decimal place. For instance,

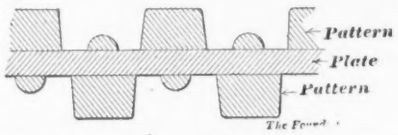


FIG. 8—STAGGERED PLATE PATTERN WITH PORTIONS OF PATTERN ON EACH SIDE OF PLATE

1.127 indicates a permissible error of 0.001 inch
1.120 indicates a permissible error of 0.001 inch
1.12 indicates a permissible error of 0.01 inch
1.10 indicates a permissible error of 0.01 inch

Reference to Figs. 2 to 14, illustrating the various methods of carding, and to Figs. 15 to 25, illustrating the location of the parting line, will show that many different arrangements for draft are possible, although only one may be desirable. The pattern drawing should therefore show where the parting comes, and should indicate the amount of draft to be allowed at different points. The allowances for draft are discussed in detail under a separate heading.

A carding drawing should be prepared in conjunction with the drawing of the pattern itself. These must be carried along together, as a change

in one will usually affect the other. The carding drawing should show clearly the arrangement of the runner, the enlarged portion of the runner where the sprue is to be cut, the location and size of the gates, the points at which they join the patterns, the arrangement of the patterns, the location and size of risers or shrink balls, if used, and the connections, if any, which may be needed in addition to the gates for supporting the patterns. It may really be looked upon as an assembly drawing, and will usually require only a few dimensions.

To avoid the confusion which might arise if carding drawings sometimes show the drag side and sometimes the cope side, it is well to adopt the rule of showing all cardings as they would appear when looking at the drag side. In the case of an "open" carding, this rule causes the pattern to be shown as it appears when looking down on it as it lies on its mold board.

Details.

Turning now from the general requirements, we may, for convenience,

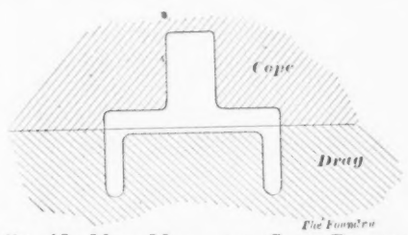


FIG. 12—MOLD MADE FROM SPLIT PATTERN

group under the following headings those details which involve a consideration of the peculiarities of each individual case:

A—The number of patterns to be grouped in one card and the size of the flask.
B—The method of carding, whether mounted on a "plate" or as a "split" pattern, or "open" for use with a mold board, etc.
C—Location of the parting line.
D—Allowances for draft.
E—Arrangement of the gates, runners, risers and supporting connections.
F—The material of the pattern, and of the runner, plate, mold board, etc.
G—The points on the pattern at which special accuracy is required.
H—The amount of work to be expended on the pattern.

These in turn depend on the given conditions, which may be tabulated as follows:

a The size and shape of the casting.
b The special requirements, if any, which may call for placing the pattern in a certain position or for providing risers, shrink balls, etc., in order to secure sound castings.
c The machining operations to be performed on the casting.
d The locating points for these operations.
e The points at which fillets and rounds are required.
f The degree of accuracy needed at unmachined portions and points, if any, where special accuracy is required.
g The rate at which the castings are to be produced.

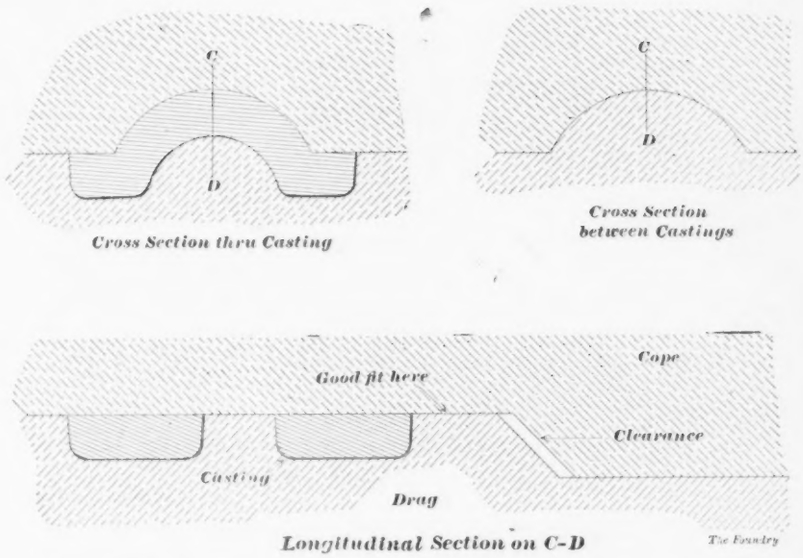


FIG. 10—CLEARANCE AT UNIMPORTANT PORTIONS OF PARTING SURFACE

h The probable total number required.
i The probable length of the intervals during which the pattern is out of use, and the conditions under which it is stored during these intervals.

Having determined the considerations affecting the design and construction, we may consider them in detail.

Number of Patterns to be Grouped in One Card.

For snap flask work it is usually necessary to allow a wall of sand about 1 inch thick outside of the extreme points of the patterns. If the card consists of a number of small patterns, the walls of sand between them tie into the outer wall and help to support it. Under these conditions no further support is necessary for castings extending say ½ inch or less above or below the parting line. If the castings are deeper, or if there is a considerable length of outer wall which is not supported by other walls tying into it, a band may have to be provided, but the one inch dimension may still be maintained. In most cases the work of handling the band is less than the work of handling the increased amount of sand required by a larger mold. Even if iron flasks are used, the one inch dimension should generally be adhered to, as there is apt to be trouble in ramming, and danger of the flask acting as a chill if the outer wall of sand is reduced much below that figure.

Flasks.

Unfortunately the manufacturers of foundry supplies seem to have made no attempt whatever to select certain sizes of flasks which can be looked

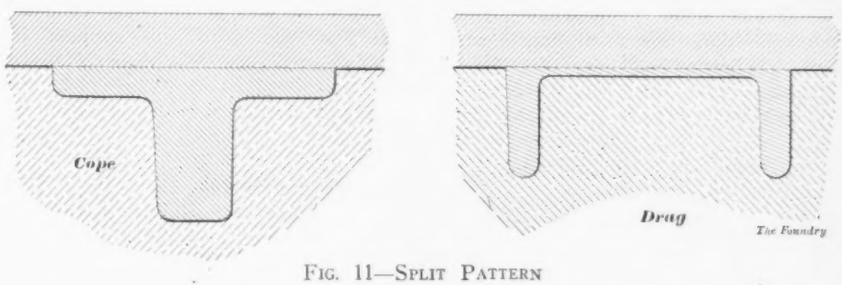


FIG. 11—SPLIT PATTERN

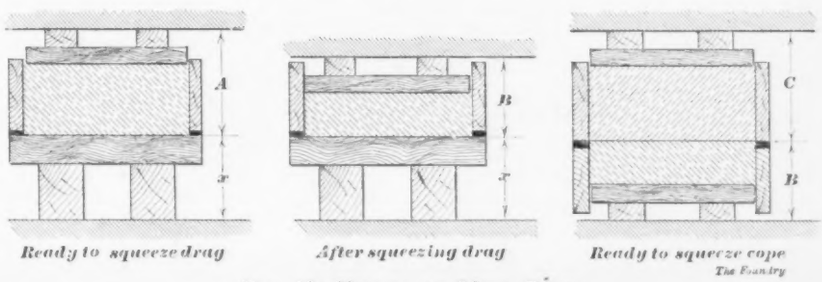


FIG. 13—HEIGHT OF MOLD BOARD

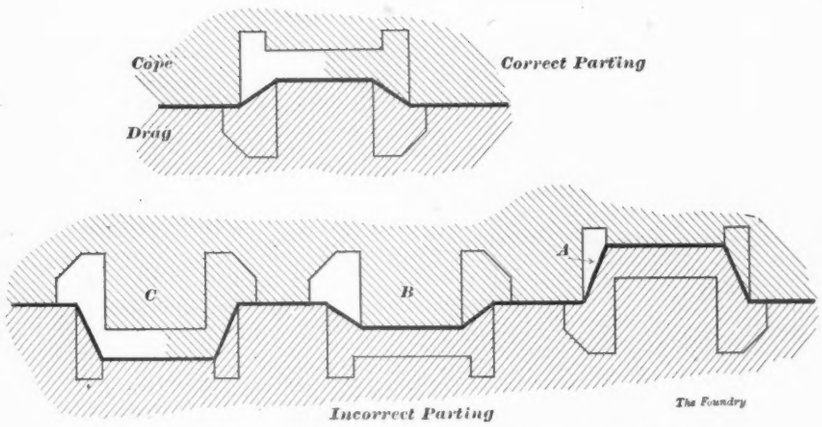


FIG. 15—AVOIDANCE OF STEEP INCLINES IN PARTING SURFACE AND OF HANGING POCKETS OF SAND

upon as standard, and therefore given the preference whenever circumstances permit. Their catalogs usually state that they will make any size of flask desired, but this does not help the man who is endeavoring to standardize his equipment.

Special sizes can never be entirely avoided, but the author recommends the general adoption of two sizes which have proved very convenient for small snap flask work. The smaller of these, 9 by 16 inches, inside measurement, is the best all round flask for work within its range. The larger one, 10 by 18 inches, inside measurement, is nearly as convenient, and there is no serious objection to its use, provided it permits of a more advantageous grouping for a given pattern. There is, however, a limit beyond which the increased weight of each mold more than offsets the advantage secured by the reduction in the number of molds. Experience shows that the output with a mold 9 by 16 inches is just about equal to the output with a mold 10 by 18 inches holding one-third more castings. Whether or not the larger flask will increase the capacity more or less than this amount can be determined only by laying out the possible groupings for each size.

Whenever there is a choice between any two sizes and their outputs are practically equal, the preference naturally rests with the smaller one as involving the smaller expense for patterns, flasks, etc.

Design of Flasks.

In fixing the length and width of a flask, the designer has usually some latitude, as he can vary the grouping of his patterns, but the depths of the drag and cope are less under his control. As the sand in the drag is never called upon to support its own weight, the depth of the drag need never be greater than is necessary to provide sufficient sand (say 1½ inches after ramming or squeezing) below the deepest portion of the pattern. The depth of the cope must be sufficient to give a corresponding amount of sand above the pattern, and it must also be sufficient to make sure that the sand will support its own weight when the cope is lifted. The depth of the cope will sometimes be fixed by one and sometimes by the other of these requirements.

If the ramming is done by hand, the mold is struck off flush with the flask, and the depth of the latter corresponds with the desired depth of the mold. If the mold is squeezed by power, the flask must be deeper than the desired depth of the mold by an amount equal to the squeeze. The squeeze may be figured as about four-tenths of the original average depth of loosely packed sand.

If the pattern is mounted in a frame, the depth of the drag half of the flask must be further corrected by deducting an amount equal to the thickness of the frame. The frame should always be considered as belonging to the drag half of the flask.

Table I gives the minimum depth of flask which experience has shown to be permissible for a cope, squeezed by power, in order that the sand may support its own weight.

Table I.

MINIMUM DEPTH OF FLASK.

Size of Flask in Inside Measurements.	Minimum Depth of Flask Giving a Cope that Can be Lifted.	Approximate Depth of Cope Half of Mold.
9 by 16 inches	3 inches	1⅞ inches
10 by 18 inches	3¼ inches	2 inches
12½ by 17½ inches	3½ inches	2⅛ inches
13½ by 15½ inches	3¾ inches	2¼ inches
14 by 23 inches	4 inches	2⅜ inches

If the conditions require a deep flask, or one which is larger than

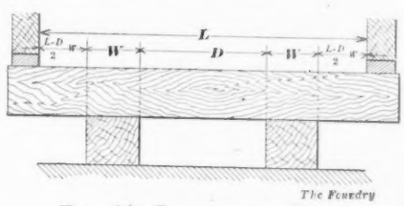


FIG. 14—SPACING OF CLEATS

either of the two sizes mentioned, care should be taken whenever possible to avoid molds beyond the capacity of a single operator.

For snap flask work the limits for a one-man mold are about as follows:

A—Width 12 inches inside of flask. A greater width makes the mold liable to tip toward or from the operator.

B—Length 24 inches inside of flask. A greater length requires an excessive spread of the arms.

C—Weight 85 pounds corresponding roughly, for flasks of average depth, to an internal flask area of 250 square inches.

Care should be exercised to avoid molds which are square or nearly square, as they are liable to tip, even if the width is less than the 12 inches specified above. The best shape is obtained when the width is from 5/10 to 6/10 of the length.

When carrying a mold supported by a solid flask the operator can rest

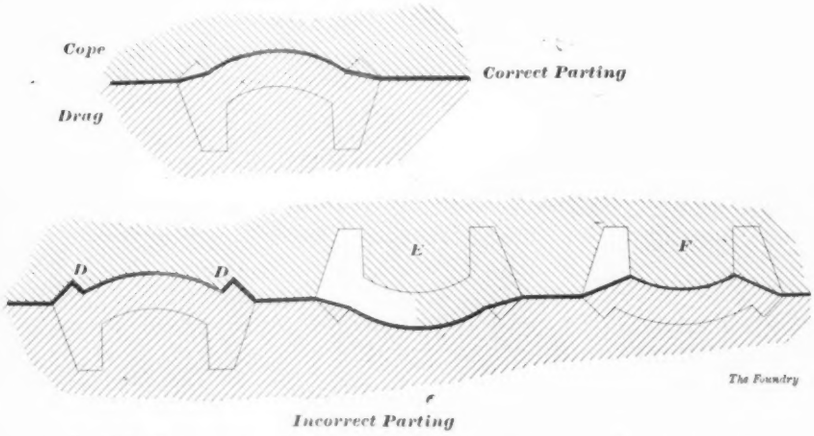


FIG. 16—AVOIDANCE OF UNSUPPORTED PROJECTIONS OF SAND AND OF HANGING POCKETS OF SAND

it against his body, whereas a mold from which the flask has been removed must be swung free from all danger of contact. For this reason solid flasks may be somewhat larger than snap flasks in spite of the fact that the flask itself has to be handled in addition to the mold. The permissible increase may be taken at about 10 per cent in length, 30 per cent in width, and 50 per cent in weight.

Although output is an important consideration, we must not lose sight of the fact that it is not the sole determining factor in selecting a flask size. If the required rate of production is low and the probable total requirements small, it may pay better to mount a few patterns on a small card in preference to carding even a considerably increased number for a slightly larger flask. Further reference to this will be made under heading, "The amount of work to be expended on the pattern."

Every possible care should be exercised to limit the number of different sizes of flasks. A record should be kept of all existing sizes, and no

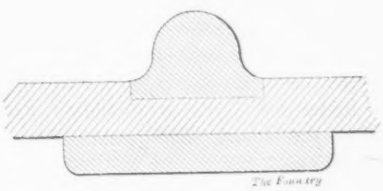


FIG. 22—PATTERN INSERTED IN PLATE TO PROVIDE GOOD FILLETS

new size should be created unless it is perfectly certain that none of the old ones are suitable.

Method of Carding.

It will nearly always be a safe rule to use a plate whenever the pattern permits. It gives the most durable construction, and except in special cases, such as those shown in Figs. 5 and 11, it permits of making both halves of the mold at once. The simplest case arises when one side of the pattern is flat, permitting it to be mounted as shown in Fig. 2.

If, instead of being shallow, the pattern is deep, a considerable space must be left between adjoining patterns to give a sufficient wall of sand. In such a case a saving can be effected by putting the patterns alternately above and below the parting line as in Fig. 3. This can be arranged in two ways, by actually mounting patterns on both sides of the plate, as in Fig. 4, or by making only half the number of patterns and mounting them on one side as shown in Fig. 5.

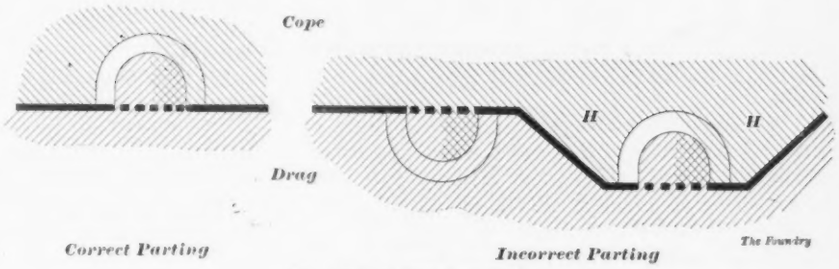


FIG. 17—CASTING IN COPE

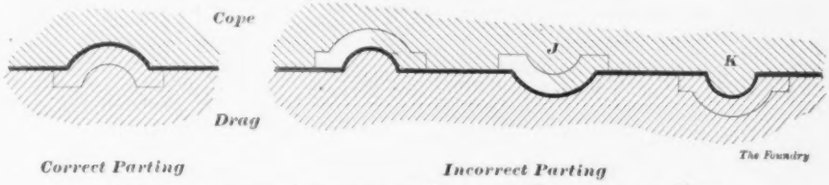


FIG. 18—CASTING PARTIALLY IN DRAG AND PARTIALLY IN COPE

Reversible Plates.

It is evident that if the first half mold made is used as the drag and the next one turned over and placed on it as the cope, the desired staggering will be obtained. This style of plate is sometimes known as a "reversible plate," although, strictly speaking, it is the mold and not the plate that is reversible.

The first method gives the greater output, as both halves of the mold may be made at once. It is to be preferred for shallow patterns of simple form, as it obviates the necessity for special accuracy in locating the patterns and keeping flask pins true. If the pattern is complicated, a decided saving in pattern cost can be effected by using the second method. If the pattern involves a deep draw, the second method is again to be preferred, as it requires only the lifting of the pattern from the sand, and not the lifting of the cope off of the pattern. The "reversible" method has the disadvantage which may in some cases prove serious, of producing half the castings under one set of gating and cooling conditions and half under another set.

Careful work to make the two sides of the plate match, and to keep the flask pins true is necessary if portions of the pattern have to be mounted on opposite sides of the plate. If a square corner is permissible at A, they may be mounted as in Fig. 6. If a round corner is required at both A and B, they must be mounted as in Fig. 7. The staggered arrangement can also be used for patterns extending on both sides of the parting line as in Fig. 8.

In order that the two halves of the mold may meet properly the vertical distance between the upper and lower faces of the plate must be constant throughout, excepting at certain points where an excess thickness is purposely provided, as referred to later. This condition can be easily met if the parting surface is a plane, but prohibits the use of a plate if this surface assumes a complicated shape. If the surface can be given some simple geometrical form which can be easily machined, a plate can often be

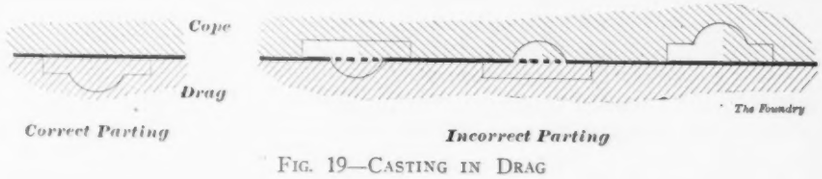


FIG. 19—CASTING IN DRAG

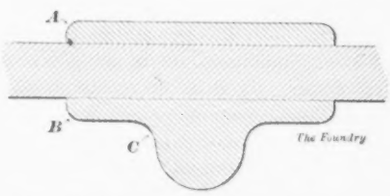


FIG. 20—PLATE PATTERNS WITH ALL CORNERS ROUNDED

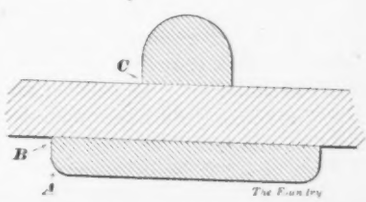


FIG. 21—PLATE PATTERN WITH SOME CORNERS LEFT SQUARE

used to good advantage even if the parting is not in a single plane. Several cases of this kind are illustrated in Fig. 9.

In making such plates, the best results will be obtained if a little extra thickness is given to the plate at any points where an exact fit of the mold is not required. For example in the first of the patterns shown in Fig. 9, the different sections through the molds should appear as shown in Fig. 10.

Split Patterns.

The "split" pattern is really a modification of the patterns shown in Figs. 6, 7 and 8, which is used if the draw is so deep that the cope can not well be lifted off of the pattern. In such a case the pattern is split, each half being separately mounted as in Fig. 11. The pattern is lifted from the drag and also from the cope, and the latter is turned over and set on the drag, making the completed mold appear as in Fig. 12. If used with a stripping plate the principle is the same, only the patterns are reversed and drawn downward through the plate, instead of being lifted up. If the casting happens to be symmetrical about the parting line, a single pattern can be used for both the drag and cope.

If the parting surface is too irregular for a plate the ordinary pattern connected to a runner and provided with additional supports, if necessary, must be used, so as to make an "open" carding. As this construction gives no backing to the pattern, a separate support must be provided in the form of a mold board. The use of the mold board makes it impossible to ram up both halves of the pattern at once. If power squeezers are used with this style of pattern, special care must be taken to give the drag a heavy squeeze and the cope a light one. If this precaution is not observed the pattern will be sprung, and pressed still further into the drag half, when the cope is squeezed. When ramming by hand there is less danger of springing as the support afforded by the drag has to resist only the localized blow of the rammer instead of a pressure exerted simultaneously over the entire parting surface.

If the molds are squeezed by power, it is desirable to put cleats under the mold board so that the total height will be such as to keep the idle portion of the stroke as small as possible at all times.

From Fig. 13

$$A + x = B + C$$

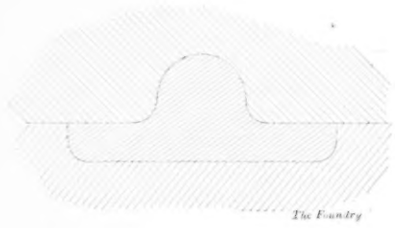


FIG. 23—FILLETS IN OPEN CARDED PATTERNS

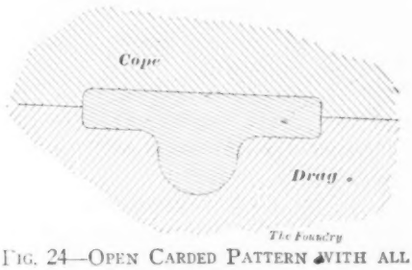


FIG. 24—OPEN CARDED PATTERN WITH ALL CORNERS ROUNDED

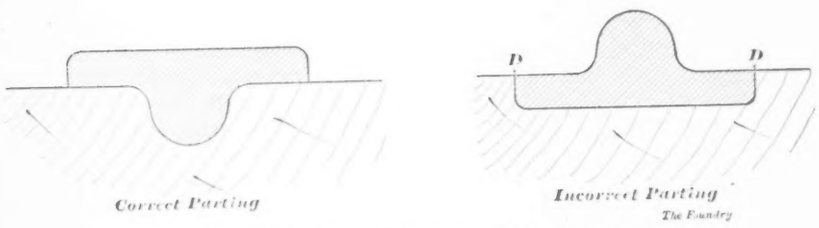


FIG. 25—PATTERNS LET INTO MOLD BOARD

it follows that

Desired height of mold board, $x = B + C - A = C - (A - B)$

where C is the combined height of cope and squeezing board before squeezing, and A — B is the amount of squeeze in the drag.

Location of Cleats.

Locating the cleats so as to reduce the deflection of the mold board to a minimum is a matter which deserves attention, particularly in the case of long flasks. It may be assumed that the pressure exerted on the mold board through the sand is practically uniform at all points, and the mold board may therefore be treated as a girder, resting on two supports and uniformly loaded as shown in Fig. 14.

For a pressure of P pounds per inch of length, the deflections may be represented as follows:

Deflection at ends of mold =

$$\frac{P\left(\frac{L-D}{2} - W\right)}{8} \quad \frac{\left(\frac{L-D}{2} - W\right)^3}{EI}$$

Deflection at center of mold =

$$\frac{P\,D}{384} \quad \frac{D^3}{EI}$$

Placing these equal to each other, and solving we get

$$D = \frac{\sqrt[4]{3}}{\sqrt[4]{3}+1}\,(L - 2W)$$

$$D = 0.568\ (L - 2W)$$

The cleats on the bottom boards and squeezing boards should be centered with the cleats on the mold boards. The thickness of the squeezing board and of the bottom board, including the cleats in both cases, must be greater than the distance traveled in squeezing. The middle view in Fig. 13 will make this clear.

Location of Parting Line.

The location of the parting line, both with reference to the pattern itself, and with reference to the edges of the flask, is highly important, and the judgment used in its selection may make the whole difference between success and failure in producing the molds.

In locating it we should be governed by these rules:

A—Avoid steep inclines in the abutting surfaces of the drag and cope. Always keep these surfaces as nearly square to the line of lift as possible.

B—Avoid unsupported projections of sand, particularly in the cope. Avoid hanging pockets of sand in the cope.

C—Make the draw in lifting the cope as small as possible.

D—Where a draw in the cope is unavoidable, endeavor to keep it up within the flask so that the latter will support it.

E—When practicable, avoid a parting surface which intersects a face of the casting. Give the preference to a parting which forms a continuation of a face even if a rounded corner has to be sacrificed.

F—If a mold board is used, avoid exposed joints between it and the pattern.

Following these rules, the first of the partings shown in Figs. 15 to 19 inclusive are the ones to be preferred in each case. Partings similar to those shown in Figs. 20 to 24 inclusive should be used only if necessary, and of the two partings shown in Fig. 25 the first is to be preferred.

Fig. 15 illustrates the avoidance of the steep incline at A and of the hanging pockets of sand at B and C. Fig. 16 illustrates the avoidance of the unsupported projections of sand at D and of the hanging pocket of sand at E and F. Figs. 17 and 18 illustrate again the avoidance of hang-

ing pockets of sand at G, H, J and K, and Figs. 15 to 19 inclusive illustrate the features of keeping the draw in the cope as small as possible, and of keeping it up inside of the flask.

It is interesting to note that the application of these rules results, in different cases, in locating the casting in each of the three possible positions in the mold, namely: entirely within the cope, as in Fig. 17; partially in the cope and partially in the drag as in Fig. 18; and entirely in the drag as in Fig. 19.

Fillets.

Fillets and rounded corners are such excellent things—in their proper places—and their importance has been written about and talked of so much, that we are sometimes led into calling for them in places where they are of no help to the casting, and really become very objectionable on the pattern.

For instance in the very simple pattern shown in Fig. 2. If it were absolutely necessary to round all the corners it would have to be mounted as shown in Fig. 20, adding extra expense to the making of the pattern, and making it necessary to exercise constant vigilance to keep the flask pins true.

If it were permissible for the corners B and C of Figs. 20 and 21 to be square, the pattern might be mounted as shown in Fig. 21. This would still permit of a round at A. If a fillet were required at C of Fig. 21, it would run out to a feather edge at the upper surface of the plate, and if a smooth and true surface were required at that point of the casting, the pattern would have to be set into the plate as in Fig. 22. The objection to this fillet applies only to "plate" patterns and not to "open" cardings. If carded "open," the mold and pattern would appear as in Fig. 23. The objection to the double rounded corners, however, holds for the "open" carding as well as for the plate, as the cope, instead of being flat, would have to be brought down as shown in Fig. 24.

Whenever a rounded corner involves the shifting of the parting line from its best position, an effort should always be made to modify the design so as to permit of a square corner at that point. If the trouble is feared from the chilling of the corner it is well to remember that in hand molding this chilling is more frequently due to wetting the mold than to the actual sharpness of the corner. In machine molding, using well made patterns with ample draft, there should be no occasion whatever for wetting the edges of the mold.

Objectionable Projections.

In avoiding objectionable projections or hanging pockets of sand, it will be of assistance to bear in mind that the mold board corresponds exactly to the cope, and that all irregularities in one will be reproduced in the other. It is therefore always desirable to keep the mold board as free from such irregularities as may be consistent with the other requirements which have to be met.

In the case of the pattern shown in Fig. 25 it makes little difference, as regards the draw, which side is put in the cope. But of the two positions shown the first is to be preferred, as it avoids the exposed joint at D. Such a joint requires careful fitting when the mold board is made, and frequent repairs are necessary to maintain its accuracy. By placing the pattern in the first position it covers the recess in the mold board entirely. In this case the recess merely becomes a clearance opening, and no fit is necessary, except perhaps at the bottom, in order to support the pattern and to prevent it from springing. The first position has the further advantage of requiring the removal of less material from the board. The carving of a mold board is a tedious and expensive hand operation at the best, and every method of reducing this expense is well worth considering.

In the foregoing we have considered molding conditions but not casting conditions. A description of the latter would be beyond the scope of this paper, but attention is called to the fact that they may at times necessitate a departure from the arrangement which would be most desirable if only the making of the mold had to be reckoned with.

CONVERTER VS. SMALL OPEN HEARTH—II

Advantages and Disadvantages of the Converter—Continuous Operation in Steel Foundries

BY W. M. CARR

THE production of light section exclusively in an open-hearth shop equipped with large furnaces has not proven entirely satisfactory because the casting of numerous small molds entails a prolonged pouring period during which the ladle of steel becomes sluggish resulting in skulls and defective castings.

It is a fact that normal open-hearth metal is fluid enough for all practical purposes, and allows the pouring of all light work from the first part of a heavy heat (10 tons or more). It is obvious that losses from skulls and miss-run castings can be avoided by reducing the size of the heats and thus shorten the pouring period. In other words, casting less metal into fewer molds, is a logical step in open-hearth practice in its adaptation to the production of light parts and tonnages, consequently a 5-ton open-hearth furnace (acid or basic) delivering metal of the same normal casting temperature as larger furnaces, will turn out more effective work, for the purpose under consideration, by virtue of the shortened pouring period.

Advantages of the Converter.

The advantages of the 2-ton converter are as follows:

(1) It can be cheaply installed. (Approximate costs later.)

(2) It can be started up in short notice and operated at irregular intervals.

(3) It is well adapted for light sections, (a) when strength is important or, (b) when strength can be neglected.

(4) It produces steel of such a high temperature that it can be transferred to hand ladles with but moderate skill, and permit lip casting of molds, a feature that favors lessening the size of gates and a better quality of product because the size of the stream of metal is under good control. In other words, the castings may be more solid than in bottom pouring methods.

(5) Its product is of good quality, bearing inspection in chemical and physi-

cal tests with that of open-hearth or crucible steel of like composition.

Disadvantages.

The disadvantages can be summed up as follows:

(1) No objection can be cited against advantage (1).

(2) The claim of the possibility of irregular operation proves to be costly. An organization must be maintained during intervals of idleness. If but one heat per day is considered as a minimum its burden of operating expense will be as heavy as two heats every other day. In any event the converter must be preheated internally by coke or oil preparatory to blowing. Coke will burn to ash, more or less, which acts as a non-conductor so that the bottom of the converter will be cooler than its sides. An oil flame, however, will give a more uniform heat. But a preheating does not always heat the converter fully before it can receive a molten charge of pig iron with the result that a single heat may be too cool and cause losses through skulls, etc. The necessary preheating of the converter adds to the cost of production through the consumption of extra fuel. The economy in small irregular outputs is doubtful, on such a basis, and the owner of a converter would be safer financially to fill his orders through outside sources.

Continuous Operation.

Continuous operation is the keynote in any steel casting method, the greatest possible quantity in the briefest possible time and as frequently as possible. Irregular, intermittent work must yield uncertain profits, carry heavier charges for labor and superintendence, etc., than steady regular production, aside from any consideration of prices of material or initial outlay for an installation.

Continuous operation will be defeated with but one converter. It must be taken off for repairs every 20 or more heats occupying several days in relining, drying and warming. For continuous production it is recommended that three 2-ton converters be erected. The practice would then be, one active, one in course of repair and one warming up. The cost of such an installation while less than an average open-hearth furnace, will be about the same as a small open-hearth so that the element of cheapness, comparatively, will be open to question in regard to relative costs of the two methods.

(3) Its adapability to light sections is purely one of cost and its value will be competitive with crucible steel (a), and malleable (b), but the force of the advantage will be weakened or supported by conditions in the preceding section.

(4) The high initial temperature of the steel from the converter, brings into play the personal equation in a pronounced manner. The judgment of the proper casting condition rests with the foreman or blower. The practiced eye is the sole guide. The point is one which must be closely watched. If his judgment is at fault from any cause and the metal is poured at too high a temperature, there will be heavy losses through "hot-cracks." It is recognized that such a weakness is common to the side-blown converter and is a more prolific source of loss in defective castings than any other method of production. The proper casting temperature being subject to eye measurement is a greater variable than open-hearth temperatures, and, therefore, is a drawback.

(5) In regard to quality, the ultimate of a desired finished composition is not entirely dependable. The analysis of a given heat may be uniform throughout but in comparison with other heats where uniformity of product may be sought regularly there will be variations. The content of carbon, silicon and manganese in the final analysis varies with the quantities of the usual deoxidizers used and the composition of the charge of metal at the end of the blowing operation, and, unless the weight of steel produced is known with a fair degree of accuracy and its composition at that stage, there will always be an element of guess work as to dosing to reach a certain analysis.

Final Composition.

The final composition at the end of the conversion operation depends entirely upon the personal equation and the conditions under which the blow may be conducted. The position of the tuyeres, the angle of the converter while blowing, the proper blast regulation at different stages are details demanding due observance since slight variations in their various manipulations will be greatly reflected in the quality and quantity of output.

One of the common drawbacks in converter manipulation is encountered in what is known as "sloppy-blows," a violent spitting and throwing out of the mouth of the vessel large quantities of metal and slag. This particular feature is largely responsible for the heavy losses in the operation of conversion. It is a decided weakness, but it is only fair to say that it can be controlled by care.

Converter Operations.

The operation of the converting process does not permit a stoppage at any stage to take samples for chemical tests. A decided disadvantage in comparison with open-hearth practice wherein tests can be taken at any stage and through their results make any needed change by different additions. The converter lacks that flexibility. Hence smooth working is at the mercy of the different detracting features set forth.

The heavy losses, previously mentioned, do not take into account losses in defective castings, gates, skulls, risers or fins, but refer only to the differences between metal charged and that yielded in readiness to pour into molds. First there will be a cupola loss of between 5 and 6 per cent and an additional loss in blowing in the converter which may vary between 10 and 25 per cent, so that there will be a total loss of anywhere from 16 to 30 per cent. The economy of the converter process must depend upon such losses. They are too vital to be regarded lightly.

The several advantages and disadvantages of the converter considered impartially, to be compared further with the advantages and disadvantages of the small open-hearth, only touch upon the salient points but they are of sufficient value to enable one to reach conclusions.

A NEW SOLDER FOR ALUMINUM.

A new aluminum solder which is strong and durable and has a low fusing point and which also unites easily with aluminum, has just been patented by Carleton Ellis, Boston. It consists of an alloy of tin and zinc, aluminum and manganese, tin being the constituent used in the greatest relative amount. The manganese is added only in relatively small quantities. The latter ingredient is used to improve the texture of the alloy and to increase the durability of the soldered joint. Chromium may be added if desired. Suitable proportions for a satisfactory solder should contain tin, 30 parts; zinc, 7 parts; aluminum, ¾ part; manganese, 1/10 part. Using chromium with manganese the mixture should contain tin, 30 parts; zinc, 8 parts; aluminum, 1 part; manganese ¼, and chromium, 1/16 part.

To secure the best results the fusion should be made in a closed crucible, as free access of air to the fused alloy will impair the wearing qualities of the solder.

THE BLAST.

The September number of *The Blast* issued "once in a while" by the Detroit Foundry Supply Co., Detroit, in addition to its usual number of pithy and humorous articles, contains a contribution on "Correct Cost Accounting for the Foundry," by E. D. Van Ness.

SPECIFICATIONS FOR IRON AND FUEL*

Methods of Testing the Foundry Output—Standard Tests—Ferro-Alloys—Scrap—Molding Sand

BY RICHARD MOLDENKE

ALTHOUGH one often hears of the fine castings produced by the numerous smaller foundries, where specifications and analysis for purchase and sale are disregarded, mention is seldom made of the carloads of castings rejected on account of excessive hardness or internal sponginess. These foundries generally employ standard material, which can be spoiled only through ignorance. In special lines of foundry work, however, and in the large jobbing shops, iron and other supplies are purchased under specification and are subjected to careful inspection.

Carbon.

A comparatively simple set of specifications for all foundry supplies—pig iron, fuel, fluxes and the newer ferro-alloys—will insure ample results. Since cast iron is primarily a steel with varying carbon content, carrying large amounts of impurities and mechanically mixed with graphite, it follows that a wide range of metal for casting purposes may be secured by varying the proportions of the impurities and of the combined and free carbon. Thus, a cast iron with but 0.20 per cent of combined carbon and near 4 per cent of graphite will really be a "twenty" carbon steel, the graphite merely causing the metal to act like cheese under the tool. The addition of steel scrap to the original mixture—thereby reducing the percentage of graphite without materially altering that of the combined carbon—strengthens the metal, which now, however, will not cut as readily under the tool. Proceeding further, an increase in combined carbon and a reduction in graphite, secured by reducing the silicon, will produce an "eighty" carbon steel, with so little lubrication for the tool as to be too expensive to machine.

In this way by varying the proportions of combined and free carbon, a wide range of metal is obtained, beginning with the soft, weak, easily machined black iron, rich in graphite, running through the gray and mottled grades, and ending in a hard, strong, white iron susceptible only to being ground.

Machinery and Malleable Castings.

Since the relative proportions of combined and free carbon may in a great measure be controlled through the silicon, it is generally sufficient to specify the maximum allowable percentages of sulphur, phosphorus and manganese. Normally blown irons, from reputable blast furnaces, run so uniform in carbon content as to render specification unnecessary. An "off cast" renders itself quickly apparent through the other impurities, and is sold only under its true designation.

For ordinary machinery castings (gray iron) the pig iron used as part of the charge should contain:

Sulphur, not more than.....0.05 per cent
Phosphorus, not more than...0.50 per cent
Manganese, not more than....0.80 per cent
Silicon, from 1.75 per cent to 2.75 per cent, as specified.

For malleable castings (white iron) the pig iron used should contain:

Sulphur, not more than.....0.04 per cent
Phosphorus, not more than..0.225 per cent
Manganese, not more than...0.60 per cent
Silicon, from 75 per cent to 1.50 per cent, as specified.

A variation of 10 per cent, either way, from the above figures may be allowed.

Light Castings.

Where light castings are desired, as for stoves and art work, the phosphorus is specified at 1.00 per cent and over, and the silicon often as high as 3.25 per cent. Similar specifications may be prepared to cover the rest of the 13 rather distinct grades of cast iron, with their more than 40 variations.

To enable foundrymen unacquainted with the metallurgy of cast iron to buy intelligently, the American Society for Testing Materials, through its committee on specifications for foundry iron, prepared schedules designating the composition of the very deceptive but well known, old grade numbers. Thus Nos. 1, 2, 3 and 4 are to contain 2.75, 2.25, 1.75 and 1.25 per cent of silicon, respectively, fracture appearances being disregarded. Sulphur is specified at less than 0.035, 0.045, 0.055 and 0.065 per cent, respectively, when estimated volumetrically, with an allowance of one hundredth more in case the gravimetric method is employed. A variation of 10 per cent of silicon, either way, from the above figures is allowed; and the sulphur may vary 0.02 per cent. A deficiency of over 10 and under 20 per cent does not lead to rejection, but entails a penalty of 4 per cent in price. This is eminently fair, and protects manufacturer and foundryman alike.

In sampling, each car is taken as a unit, and from this one pig is selected out of each four tons. In case of dispute, a pig is selected from each two tons, the loser paying for the additional labor caused by the closer sampling. Drillings from these pigs taken so as to fairly represent the fracture surface, are to be well mixed before analysis.

It is interesting to note that the liberality of these specifications, appealing as it does to the conservatives, is in direct contrast to the severer requirements of the foundryman who buys by specifications of his own.

Fuel for Foundry Work.

Ordinary foundry operations require as fuel anthracite, coke and soft coal, while producer gas, natural gas and oil are employed in the special brass furnaces and the open-hearth for steel and high grade iron. Necessity for specification is confined to bituminous coal and coke, and in the case of the former only the sulphur, and occasionally the ash, demands attention. The increasing use of the air furnace for the manufacture of high grade engine castings is leading to a study of the availability of various soft coals; and the United States geological survey, through its advisory board on fuels and structural materials, has gathered much information, so that specifications for coal and coke for melting purposes may be expected soon. In the meantime, it may be stated that no coal containing more than 2 per cent of

*Presented at the annual meeting of the American Society of Mechanical Engineers.

sulphur should be used in the foundry, and, preferably, the amount of this impurity should be limited to 1 per cent. Similarly, the ash should be limited to 10 per cent.

Coke.

The employment of coke demands closer attention to moisture, to the remaining volatile matter, fixed carbon, sulphur, ash and sometimes phosphorus. Usually, however, the sulphur, ash and fixed carbon are sufficient to give a fair idea of the value of coke, apart from its physical structure, specific gravity, etc. The advent of by-product coke will necessitate closer attention to moisture. Bee-hive coke, when shipped in open cars where it absorbs much moisture, may, through inattention, cause the purchase of from 6 to 10 per cent of water at coke prices.

Concerning sulphur, there is much to be ascertained; whether its sulphates or its volatile compounds get into the iron, and how. Foundry practice, however, has recognized the fact that a very hot running of the cupola results in less sulphur in the iron. In good coke, the amount of sulphur should not exceed 1.2 per cent; but, unfortunately, the percentage often runs as high as 2.00. If the coke has a good structure, an average specific gravity, not over 11 per cent of ash and over 86 per cent of fixed carbon, it does not matter much whether it be of the "72-hour" or "24-hour" variety. Departure from the normal composition of a coke of any particular region should place the foundryman on his guard at once, and sometimes the plentiful use of limestone at the right moment may save many castings.

Limestone to be used for fluxing should be as rich as possible in carbonate of lime, for each unit of silica transformed into slag exacts its equivalent of lime and coke. Oyster shells form a most desirable flux, and fluorspar tends to thin the slag.

Ferro-Alloys.

Use of the modern ferro-alloys will eventually be limited to the richer grades. Even today 80 per cent ferromanganese is demanded; and, while 50 per cent ferro-silicon is much used, the 75 per cent grade, or better, is specified by the wide awake foundryman. It is wasteful to employ a rich alloy in the cupola; but in the ladle, removed from the further application of heat, the smaller bulk of the richer alloy causes a smaller reduction in the temperature of the molten iron. For the present, specifications are not required for these alloys, which are made from the best material, and should be low in the undesirable elements, sulphur and phosphorus.

Scrap.

In selecting scrap iron, each foundryman chooses wornout or broken castings similar in composition to the proposed product, so that the addition of this scrap to the pig iron mixture does not disturb the calculations.

Beyond the exclusion of burnt or very dirty metal, and of sizes so small as to cause waste in melting or too large to enter the charging door, specifications for scrap iron should be limited to a statement of the class of material wanted—machinery, malleable wheels, pipe, etc.

Weak castings and castings with pin holes or with pockets under the skin, are indicative of the use of burnt metal. Three hundredths of 1 per cent of oxygen in solution in the iron as an oxide or combination of oxides is, in the case of white irons, sufficient to ruin them completely. The excessive "skulling" of ladles, and other troubles, can be traced to this cause. Thus oxygen in cast iron is far more powerful than even sulphur; yet the action of the former is little understood and does not lend itself readily to chemical investigation.

Molding Sand.

In the matter of molding sands, American foundry practice is far behind that of Germany, or of the rest of Europe. Until the price of our sands has advanced considerably, we shall continue to wet down and mix with a shovel, instead of grinding and sifting and tempering by mechanical means, as in foreign practice. Careful preparation of the sand before it goes to the molding floors will insure castings free from surface blemishes. Under present American conditions, attempts to introduce specifications for molding sands are of doubtful value.

Steel Foundry Conditions.

The absolute necessity, in the case of a successfully operated steel foundry, for the application of specification to all supplies purchased is so well understood that the steel foundry is usually classed with the steel mill, and apart from the foundry. If the acid process is used, or the Bessemer converter, the metal used is a "fancy" pig iron containing practically only iron, carbon, and the proper manganese and silicon. The basic process allows the use of cheaper material.

The characteristics of the finished product are determined either by testing each article, or by testing to destruction an occasional sample, or by the use of test bars.

If the establishment makes finished specialties in iron, ease in machining is the important requirement, and an estimate of this quality may be gained by placing an occasional cast sample disc in the lathe or drill press, the nature of the tests being dictated by the experience of each shop.

Commercial Castings.

Ordinary commercial castings, on the other hand, must be subjected to additional tests; boiler sections, to determine their resistance to pressure; valves, to ascertain whether they are tight or not. Castings produced in very large quantity must be tested to destruction, by sample, which of course, is far beyond the limits of actual service conditions. The remarkable quality of car wheels has resulted from this exacting system of testing.

The foundryman, however competent, is dependent upon the quality of the iron, for the production of serviceable castings. It is necessary, therefore, in the many cases to which testing to destruction is inapplicable to make a test of a sample form composed of iron identical with that in the casting. Today in foundry practice the foundryman may employ shop test bars of such size and shape as he chooses. Comparison of the performance of his test bar with that of the purchaser's test bar will enable the experienced foundryman to determine the degree of exactness with which he is meeting the requirements.

Standard Tests.

Finding that such a variety of standards prevailed, the American Foundryman's Association and the American Society for Testing Materials, under separate action, but by individual members of each committee, have adopted a set of specifications which embodies the last word on this complex subject. These specifications depart entirely from established procedure.

It has been attempted in these specifications to avoid the introduction of outside influences as far as practicable, and to have the sample represent accurately the iron as it comes from the cupola or the furnace. Hence, the round sample bar is to be of as large size as the limits of commercial testing machines will permit, it is to be poured in a vertical position, to avoid the difference of

METHOD OF ASCERTAINING THE WEIGHT OF CASTINGS FROM THE WEIGHT OF PATTERNS.

Pattern weighing one pound.	Weight when cast in: Cast Iron. Pounds.	Yellow Brass Pounds.	Gun Metal. Pounds.	Zinc. Pounds.	Aluminum. Pounds.	Copper. Pounds.
Bay wood	8.8	9.9	10.3	8.5	3.2	10.5
Beech	8.5	9.5	10.0	8.2	3.1	10.1
Cedar	16.1	18.0	18.9	15.6	5.8	19.2
Cherry	10.7	12.0	12.6	10.4	3.9	12.8
Linden	12.0	13.5	14.1	11.6	4.3	14.3
Mahogany	8.5	9.5	10.0	8.2	3.1	10.1
Maple	9.2	10.3	10.8	8.9	3.2	11.0
Oak	9.4	10.5	11.0	9.1	3.4	11.2
Pear	10.9	12.2	12.8	10.6	3.9	13.0
Pine, white	14.7	16.5	17.3	14.3	5.3	17.5
Pine, yellow	13.1	14.7	15.4	12.7	4.7	15.6
Whitewood	16.4	18.4	19.3	15.9	5.9	19.5

Allowance should be made for any metal in the pattern.

SPECIFIC GRAVITY AND AVERAGE WEIGHT PER CUBIC FOOT OF PATTERN LUMBER.

	Specific gravity.	Average weight per cubic foot.
Beech	0.73	46 Pounds.
Cedar	0.62	39 "
Cherry	0.66	41 "
Linden	0.60	37 "
Mahogany	0.81	51 "
Maple	0.68	42 "
Oak, white	0.77	48 "
Oak, red	0.74	46 "
Pine, white	0.45	28 "
Pine, yellow	0.61	38 "
Walnut	0.75	38 "

STANDARD SPECIFICATIONS FOR MALLEABLE CASTINGS.*

Process of Manufacture.

Malleable iron castings may be made by the open-hearth, air furnace or cupola process. Cupola iron, however, is not recommended for heavy nor for important castings.

Chemical Properties.

Castings for which physical requirements are specified shall not contain over 0.06 sulphur nor over 0.225 phosphorus.

Physical Properties.

(1) *Standard Test Bar.* This bar shall be 1 inch square and 14 inches long, without chills and with ends left perfectly free in the mold. Three shall be cast in one mold, heavy risers insuring sound bars. Where the full heat goes into castings which are subject to specification, one mold shall be poured two minutes after tapping into the first ladle, and another mold from the last iron of the heat. Molds shall be suitably stamped to insure identification of the bars, the bars being annealed with the castings. Where only a partial heat is required for the work in hand, one mold shall be cast from the first ladle used and another after the required iron has been tapped.

(2) Of the three test bars from the two molds required for each heat, one shall be tested for tensile strength and elongation, the other for transverse strength and deflection. The other remaining bar is reserved for either the transverse or tensile test, in case of the failure of the two other bars to come up to requirements. The halves of the bars broken transversely may also be used for tensile strength.

(3) Failure to reach the required limit for the tensile strength with elongation, as also the transverse strength with deflection, on the part of at least one test rejects the castings from that heat.

(4) *Tensile Test.* The tensile strength of a standard test bar for castings under specification shall not be less than 40,000 pounds per square inch. The elongation measured in 2 inches shall not be less than 2½ per cent.

(5) *Transvere Test.* The transverse strength of a standard test bar, on supports 12 inches apart, pressure being applied at center, shall not be less than 3,000 pounds, deflection being at least ½ of an inch.

Test Lugs.

Castings of special design or of special importance may be provided with suitable test lugs at the option of the inspector. At least one of these lugs shall be left on the casting for his inspection upon his request therefor.

Annealing.

(1) Malleable castings shall neither be "over" nor "under" annealed. They must have received their full heat in the oven at least 60 hours after reaching that temperature.

(2) The "saggers" shall not be dumped until the contents shall at least be "black hot."

Finish.

Castings shall be true to pattern, free from blemishes, scale or shrinkage cracks. A variation of 1-16 of an inch per foot shall be permissible. Founders shall not be held responsible for defects due to irregular cross sections and unevenly distributed metal.

Inspection.

The inspector representing the purchaser shall have all reasonable facilities given him by the founder to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made prior to shipment.

*Adopted by the American Society for Testing Materials.

THE FOUNDRY DATA SHEET, DECEMBER, 1907.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

strength between top and bottom, if poured horizontally; and the mold is to be dried, to ward off the effect of damp sand. The speed of testing is specified, and a regular routine of pouring is to be observed. At the suggestion of Mr. Walter Wood, this bar is called the "arbitration bar," as it is intended for use only in case of dispute between buyer and seller.

The new method of testing, as adopted by the American Society for Testing Materials, is being generally used, and is found to be far superior to the old custom of flat, square bars of small cross section, or the long bars so susceptible of dishonest manipulation. The transverse is best suited to the peculiar nature of cast iron; but an optional tensile test is provided for, at the cost of the party demanding it, although in Germany this latter test is excluded altogether. For further details, the reader is referred to the publications of the two societies mentioned heretofore.

Metallurgy.

The ethics of the cast iron industry has been dependent upon the better understanding of its metallurgy. In times past the foundrymen refused orders to which specifications were attached; and he refused even to provide tentative specifications which might enable the buyer to obtain such iron as he desired to purchase. Now this is changed, and the progressive foundryman welcomes inspection of his methods and tests of his product.

It is to the lasting credit of the foundry that the first demand for specifications came from the foundrymen themselves, through their association, and that they co-operated heartily with the engineer by furnishing information, freely and without reserve. A very friendly feeling between buyer and seller has ensued; for no better evidence of good faith can be given than an invitation to visit freely the shops and the laboratory to inspect manufacture and test. This is the rule today, not the exception.

TROLLEY WHEELS.

Question.—What alloys are used for making trolley wheels?

Answer.—A suitable alloy contains 16 pounds of copper to one of tin, to which three pounds of zinc are added for every 100 pounds of the mixture. No lead is used in trolley wheels, as there is a danger of arcing. Phosphorus is used to harden copper wheels. The medium hard alloy contains ½-pound stick of phosphorus for every 100 pounds of copper. Another good copper alloy should contain 97 pounds of copper, two pounds of tin and one pound of silicon copper. The diameter of the ordinary standard trolley wheel is five inches, and wheels six and seven inches in diameter are also used. The greater the diameter of the wheel, the better service it will render. The size of the wheel however, is limited by its weight, the 7-inch wheel being almost too heavy for the trolley base, the springs being unable to hold the wheel against the wire.

IMAGINARY DIFFICULTIES

BY H. SAYERS

THOUGH not a patternmaker I have read the paper on "Shop Kinks and Don'ts for Patternmakers," which appeared in the August issue of THE FOUNDRY, with both pleasure and profit. In its way it is one of the most valuable contributions to pattern shop practice which has recently appeared.

However, I would like to suggest two additional "Don'ts." First, don't forget that patterns are simply a means to an end—castings. Second, don't fail to keep in touch with the men who make the castings, or you may imagine difficulties that do not exist, and in attempting to overcome them you may introduce other difficulties that are still more complex.

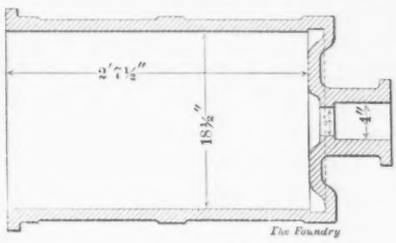


FIG. 1

The following example is taken from actual practice: Fig. 1 shows a section of a locomotive cylinder barrel, while Fig. 2 shows the core board for striking the core for the same. The castings were ordered by a firm of locomotive builders not operating its own foundry. In view of this fact it is reasonable to suppose that the patternmakers were not in touch with actual foundry practice. From the design of the core board it would appear that the patternmaker on this job concluded that it would be difficult to get the board away after striking the barrel. To overcome this imaginary difficulty he made the board as shown and made two core boxes, Fig. 3, for the two half cores, Fig. 4, to fill up the missing portion. Every patternmaker can appreciate the amount of time required and the material wasted in making these two boxes, and every molder familiar with this class of work will appreciate the difficulty of securing these two heavy half cores on a 3-inch barrel in such a way that they would be square with the straight part of the body core, and in no danger of shifting when up ending the mold for casting. Furthermore there was a big loss of time in making these two cores.

The joint in the core boxes was across the center of the port clearance piece, and by the use of a change piece one of these boxes might have been saved. However, neither of them was used. In overcoming this difficulty the core board was cut out to the proper profile, and by careful manipulation was drawn away satisfactorily after striking the core.

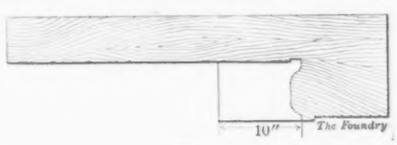


FIG. 2

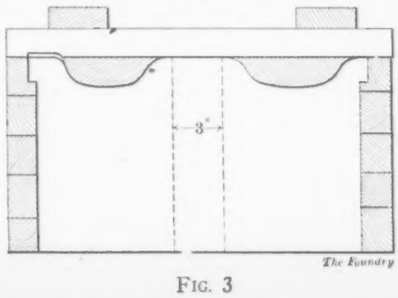


FIG. 3

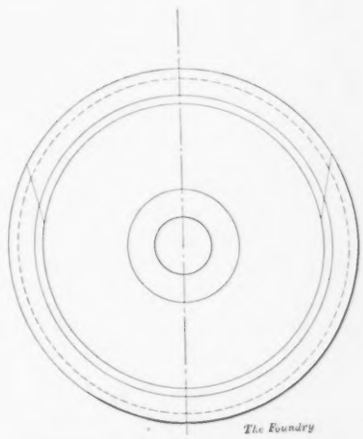


FIG. 4

A FOUNDRY FOR BENCH WORK*

Rapid Reconstruction of the Foundry of the Michigan Stove Co.—Ideal Plant for Stove Plate

BY W. J. KEEP AND EMMET DWYER

ON JAN. 8, 1907, nearly the entire works of the Michigan Stove Co. were destroyed by fire. Reconstruction was begun at once and by July 1 of the same year, they were entirely completed, having been built on modern lines, substituting alternating electric current and individual motors for belts, shafting and rope drives.

On account of poor light, and lack of good ventilation on hot days, it was difficult to get molders to work in the old foundry. The new works, although surrounded by high buildings, are comfortably cool on the hottest days, and the temperature does not rise much during pouring. Fifteen minutes after the heat is off, the foundry is clear.

Before deciding on plans for the new works the writers visited several foundries, and found that of the American Stove Co. at Bedford, O., best suited to their needs. This plan was accepted with the modifications of an extra row of windows in the roof, and three monitors running crosswise instead of lengthwise.

Roof Construction.

The roof presents some new features as adapted to foundries. A small model was constructed in which an extra row of windows was placed at each side, in the central part of the slope, and the outer edge of each roof section raised to give the usual pitch of a gravel roof.

This arrangement allowed the windows in the roof to be 10 feet high, and another row 10 feet high was added on each side, which permitted the use of the ordinary gravel roof, instead of the usual felt roofing with cinders. The disadvantage of the usual felt roofing with the latter covering is that its steep slope does not permit of its being walked upon. The ordinary gravel roof has proved entirely practicable for the purpose.

Foundry.

The foundry is 128 feet square; the other dimensions are approximately, 50 feet to the top of the monitors; 40 feet to the highest point in the roof proper, and 30 feet to the roof at the sides. The girders are of 18 foot centers. As an economy in cost, a row of posts was used in the center, instead of having one truss the full length of the span.

The foundations are of concrete, the walls, 6 feet high, are of brick 12 inches thick, the balance is constructed of steel, with a roof of 2½-inch matched pine.

Fire Proof Building.

The building is so nearly fire proof that it is not considered necessary to install sprinklers. There are hydrants at two places, and fire hose with 100-pounds water pressure. There are no wooden partitions or wood work other than that covering the steel at the windows—which the architect, being more used to wood than steel construction, insisted upon using to make the building weather proof—and the charging platform, the framework of which, however, is steel with mill construction floor 8 inches thick. It is intended when the wood is perfectly dry (for the purpose of guarding against dry rot) to cover the upper surface with sheet metal and the under surface with some kind of fireproofing.

The height of 30 feet at the sides of the building is to allow a deck to be erected at some future time on the line of the top of the first row of windows. The present plan is to begin the deck 10 feet away from the side windows, making it wide enough to accommodate one row of molders, with a gangway at the edge toward the center of the foundry. The upper side of the deck will be 12 feet from the foundry floor, and the deck floor about seven feet from the underside of the lowest member of the truss.

The floor is of brick, laid in cement. One corner, 18 by 60 feet, is used for a core room, and besides there is ample room for 86 bench molders.

It has not been found necessary to open the monitor windows, it being cool enough when they are closed, but every second window can be swung open. All of the others are stationary except the bottow row, where each window swings open.

Removal of the Cupola.

Some difficulties were met in removing the cupola from the old location to its present site, a distance of 45 feet. It has a 72-inch shell, is 75 feet high, lined to the top, and is estimated to weigh 76 tons. The local movers were asked to submit bids, the lowest of which was $600, and there was no competition for the order even at that price. Finally a house mover agreed to move it for $175. There was no guarantee against accidents in any case.

The company furnished ⅝-inch wire rope for four guy ropes, which were fastened at their outer ends by tackle, and provided the men to manage them.

Two timbers were placed under the cupola from front to rear, and one crosswise. These and the cupola were raised with ordinary movers' jack screws until 5-inch wooden rollers and timbers to roll on were placed beneath. A cross timber was fastened by chains on the under timbers, and jack screws between this cross timber and the ends of the timbers and directly under the cupola shoved the cupola along.

To insure its being kept plumb, a timber projected from the charging platform door, from which a plumb-bob was suspended by a wire. A plank fastened to the base of the cupola with a nail driven so that its head was directly under the point of the plumb-bob, told which way to raise the blocking. After everything was ready the cupola was moved in 10 hours. The mover made a profit of $75, and the entire cost to the company was $225.

The foundry will be heated by the forced circulation of hot water, which is to be kept at 157 degrees. The temperature at zero weather is guaranteed to be 45 degrees. The radiation is estimated at 4,300 square feet of radiating surface, using 1½-inch pipe.

* Presented at the annual meeting of the American Society of Mechanical Engineers.

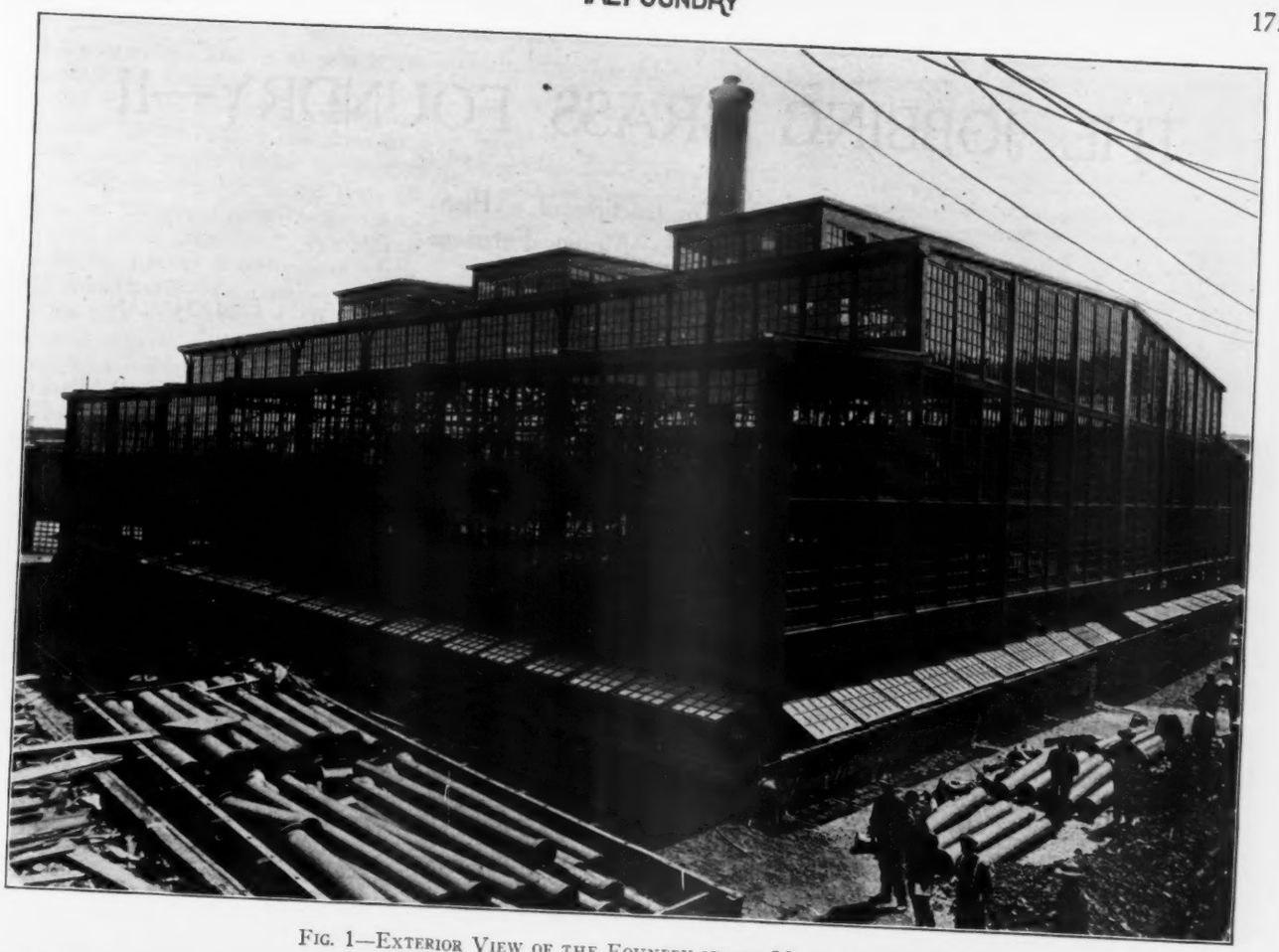


FIG. 1—EXTERIOR VIEW OF THE FOUNDRY OF THE MICHIGAN STOVE CO.

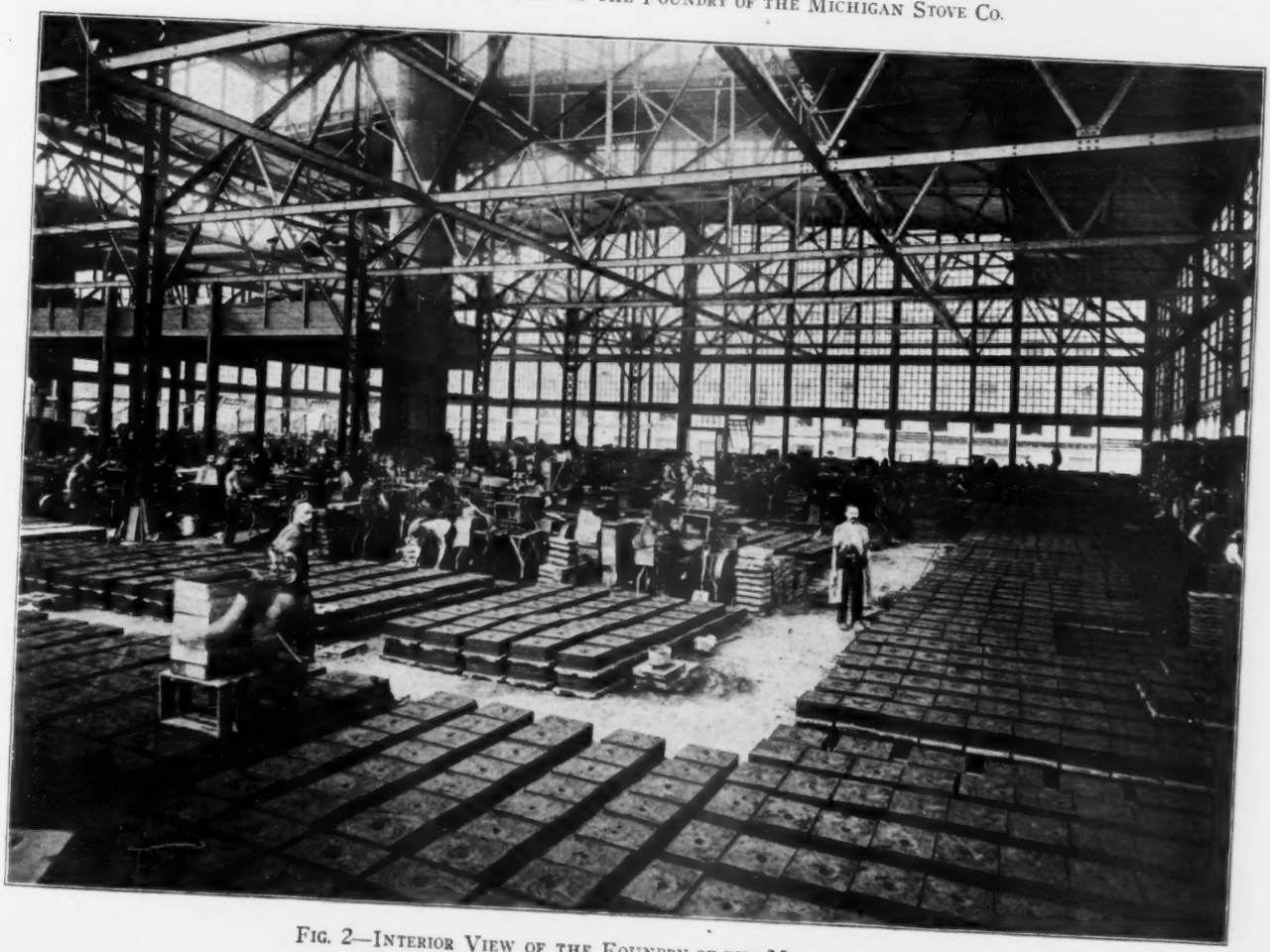


FIG. 2—INTERIOR VIEW OF THE FOUNDRY OF THE MICHIGAN STOVE CO.

THE JOBBING BRASS FOUNDRY—II

Design and Construction of a Plant for Jobbing Work—Melting Furnaces

BY J. F. BUCHANAN

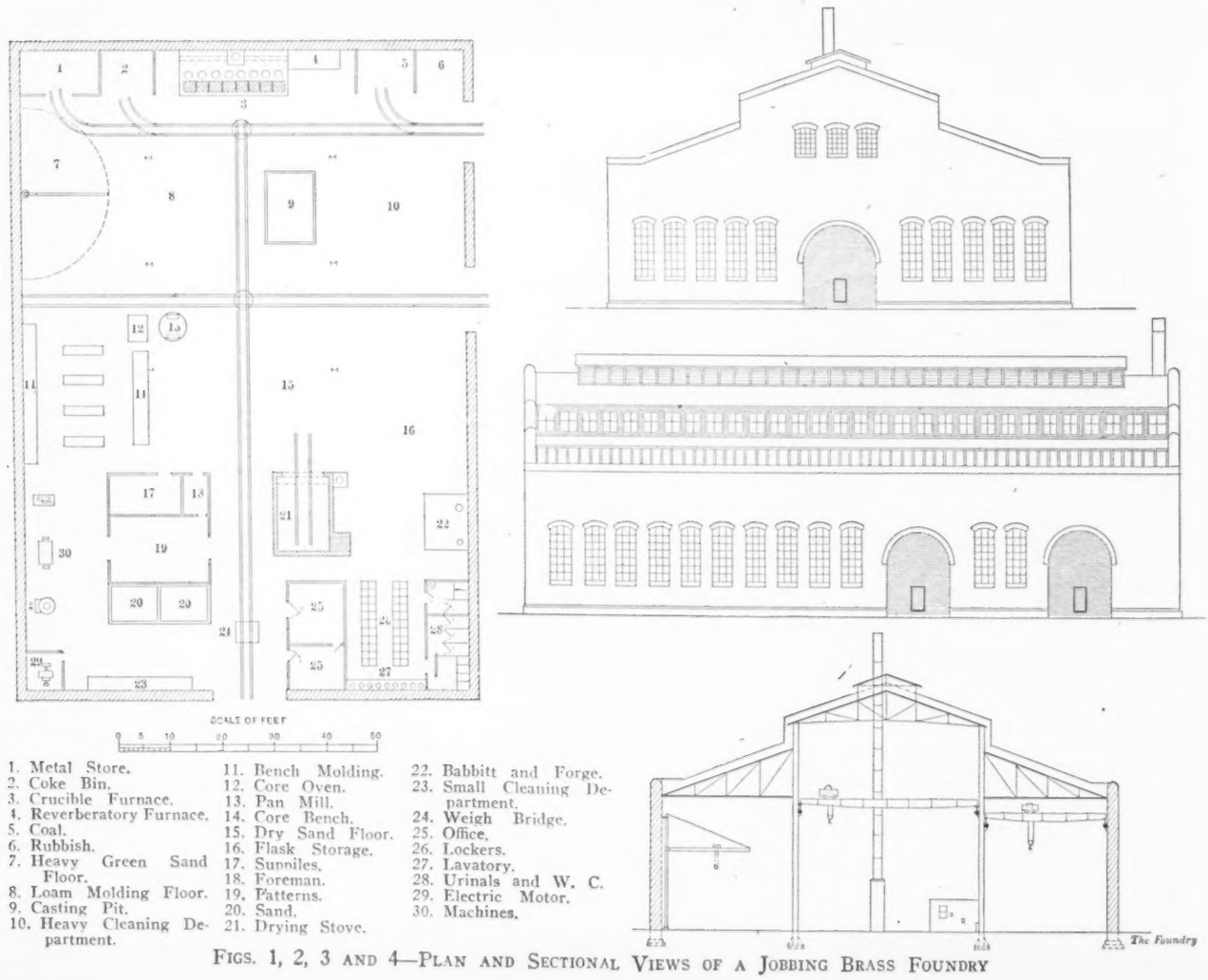
IN A PREVIOUS article we observed that the jobbing foundry was the primordial seat of that perplexing malady, "moldingitis," and the jobbing foundryman had been years and years trying to solve the problem——"How to be happy though muddled."

For muddle and makeshift and mystery there was no place to equal the jobbing foundry before the introduction of labor-saving machinery. Those who have traveled and visited the various kinds of "jobbing foundry" still to the fore will agree when I say it is difficult to define and more than difficult to focus the term. In Europe a jobbing foundry generally means a small shop in the city, (sometimes in an underground cellar) or else it is a dilapidated structure with meandering outworks, in some cheap but busy suburb. In Australia the jobbing foundry is frequently a one man show, located somewhere in the back premises attached to the dwelling of the owner, but when it assumes the dignity and dimensions of a metallic reproductions salon, corrugated iron and heavily bolted lumber constitute the covering thereof. In America (where I have never been—except cinematographically) I understand the jobbing foundry assumes a different aspect. For one thing it takes a more generous view of what constitutes a job in the line of brass founding. It opens its front door and whatever happens to drift inside is regarded as lawful prey to its jobbing instincts, and the few appliances which it keeps handy are immediately brought into action.

Evidently the chief end of the average jobbing foundryman is to find a use for "any old thing," instead of which he should consult the supplyman and aim at something like uniformity in operative methods. The successful jobber is he who prepares for the worst and hopes for the best, and the best preparations begin with the planning of the foundry.

Planning the Foundry.

There are several good ways of plan-

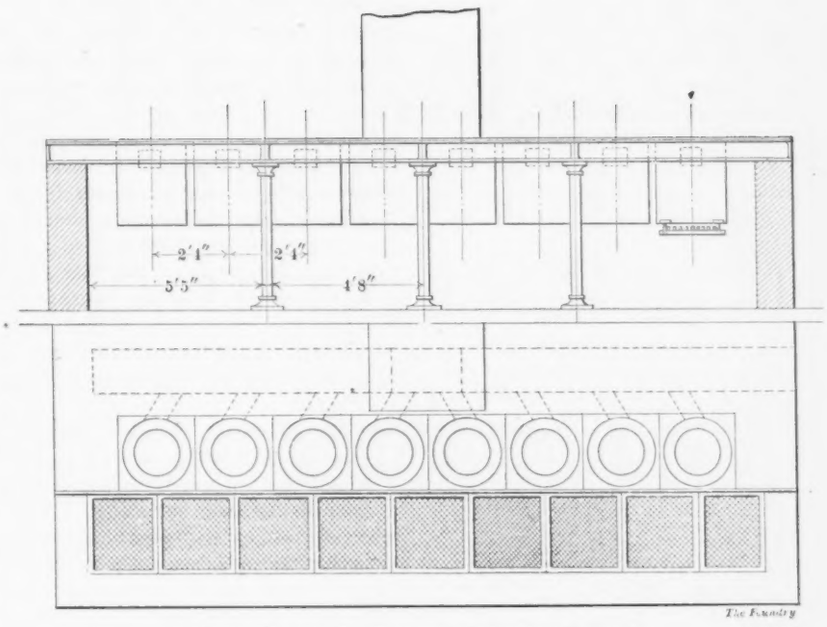


1. Metal Store.
2. Coke Bin.
3. Crucible Furnace.
4. Reverberatory Furnace.
5. Coal.
6. Rubbish.
7. Heavy Green Sand Floor.
8. Loam Molding Floor.
9. Casting Pit.
10. Heavy Cleaning Department.
11. Bench Molding.
12. Core Oven.
13. Pan Mill.
14. Core Bench.
15. Dry Sand Floor.
16. Flask Storage.
17. Supplies.
18. Foreman.
19. Patterns.
20. Sand.
21. Drying Stove.
22. Babbitt and Forge.
23. Small Cleaning Department.
24. Weigh Bridge.
25. Office.
26. Lockers.
27. Lavatory.
28. Urinals and W. C.
29. Electric Motor.
30. Machines.

FIGS. 1, 2, 3 AND 4—PLAN AND SECTIONAL VIEWS OF A JOBBING BRASS FOUNDRY

ning a foundry. One is to plan it for the plant one means to install; another is to plan it by the area of ground at one's disposal. Many people imagine there is only one correct recipe for starting a jobbing foundry. It is the same old recipe as Talleyrand gave for hare soup. —"First catch your hare." Paraphrased to fit the jobbing foundryman's ideals, this would read,—"First secure the hair of the man with the job." At any rate quite a number of jobbing businesses have been started in that way. For the present, however, we are more concerned with the layout of a modern jobbing brass foundry. The commercial pirates can maneuver the contracts while we attend to the fixings. After all, a jobbing foundry is like every other kind of foundry, commercially. Supplies come in—castings go out—and a balance is shown.

The main difference on the operative side is that we do not know exactly what to prepare for in the matter of castings. Loam, dry sand, green sand, open sand, face work, chill work and possibly a combination of two or more of these molding processes, come all in the day's work.

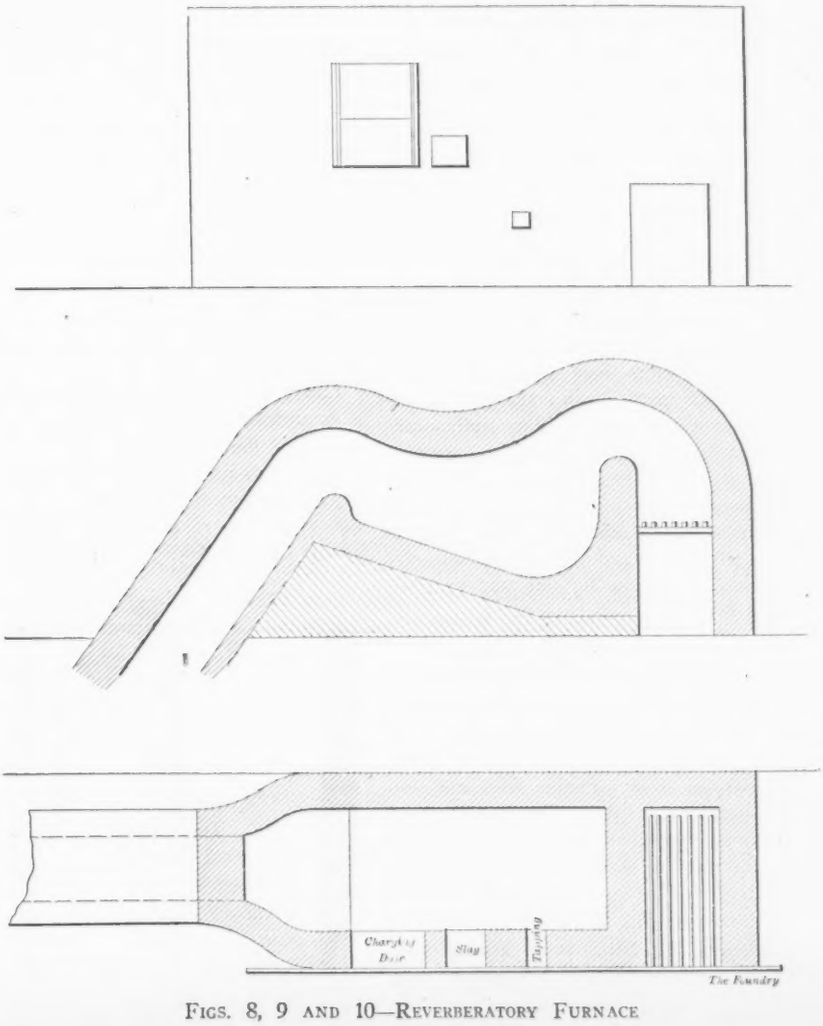


FIGS. 5 AND 6—CAISSON CRUCIBLE FURNACE

Location of the Foundry.

Location, which has much to do with the success of any foundry, is of the greatest importance for a general jobbing shop. A thriving industrial center where cheap freights, convenient transit accommodation and good sanitary conditions prevail would afford some advantages in selecting a site. The disadvantages of a city location are dear land, high taxes, and as a rule, more expensive labor. On the other hand, you are right on the spot for jobbing orders, have a better selection of labor, cheaper supplies, and the convenience of being able to purchase hydraulic and electric power from the city.

We will suppose, then, that our jobbing brass foundry is to be located in



FIGS. 8, 9 AND 10—REVERBERATORY FURNACE

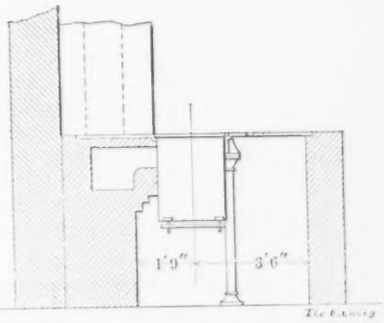


FIG. 7—SECTIONAL VIEW OF CAISSON CRUCIBLE FURNACE

one of the big, busy cities—Chicyork, Bosphila, Pittswaukie, Cleveonto, anywhere, provided there are manufacturing and engineering concerns to be catered to, but the preference should be given to a seaboard city, because marine engineering provides a big field for brass founders' jobbing.

In a city, building compactness and convenience must be the first consideration. An area of 85 x 120 feet is not colossal, but it will do to arrange a

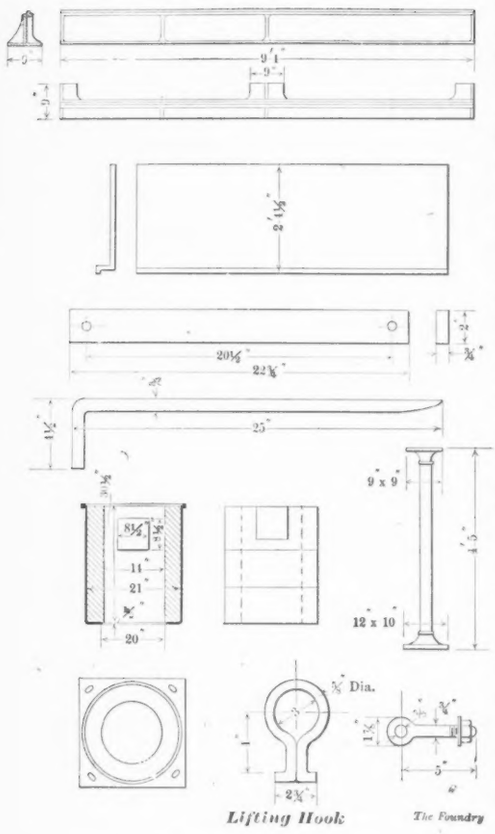


FIG. 11—DETAILS OF CAISSON FURNACE.

plant for a modest output of 10 tons per week of mixed brass castings, light and heavy. Remember, we are considering the foundry requirements only.

Plant Layout.

In the numbered ground plan, Fig. 1, there is no claim of novelty, but it will be observed that ample provision is made for all classes of work, castings up to four tons in weight being well within the capacity of this plant. The economic value of the layout should be apparent to every practical foundryman. The raw materials come in at the part where they are to be put into use, and the castings progress toward the shipping department with a minimum amount of handling. The furnaces (3 and 4) are kept at the back of the building but yet convenient to the various molding floors. The large drying stove (21) is easy of access from both sides of the craneway—a much better arrangement than having it in a corner. An auxiliary crane in the right hand bay is useful for handling heavy castings while they are being cleaned and also for storing the large flasks and tackle when they are not required in the foundry.

The casting pit (9) is a necessity for some kinds of marine work; liners, rolls, pumps and many other castings which have to be cast vertically. This pit, which should be brick-built and thoroughly drained, may be covered over and divided off into sections at the three, six and ten-foot levels, by adopting an arrangement similar to that used on the hatchways over a ship's hold. Post cranes are not shown, but it is understood that two or more on the main floor would relieve the traveler. The site for this building is supposed to be a corner block, two streets adjoining, but the same plan would suit any other position with some slight alteration of the doorways. It is always best to keep the lighter classes of work separate from the general foundry, and carrying out the same idea the small core bench is in line with the bench or tub molding and the large cores are made in line with the heavy dry sand work.

Pattern storage (19) does not make large demands on space in a jobbing foundry, even although few of the modern jobbing foundries rely solely upon jobbing for a living. Some line of goods for which there is a steady market is run in conjunction with the job orders. This helps to keep the plant fully occupied when the jobbing work slackens down and it makes it more profitable in the busy season. Fig. 2 is a sectional elevation of the building. Fig. 3 is the front elevation, and Fig. 4 is a side elevation showing the lighting and ventilating provisions.

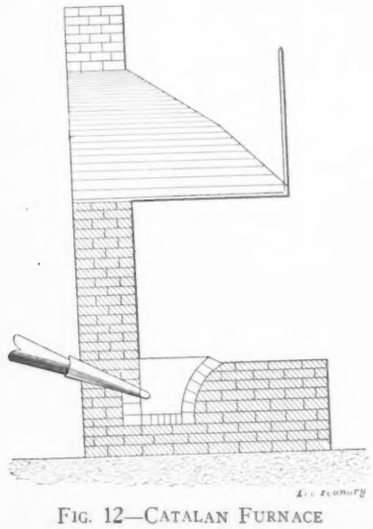


FIG. 12—CATALAN FURNACE

Furnaces.

Figs. 5 to 11 show the furnaces in detail. They are included here because many modern brass founders believe that better melting can be accomplished with the natural draft crucible fires and the reverberatory furnace. The evolution of the brass founders' crucible furnace has been a terribly slow process. From the Catalan forge, Fig. 12, to the brick-built air furnaces, Fig. 13, is one stage. In developing the latter some genius, with a strong dislike to the bricklayer's art, invented the caisson crucible furnace. This kind of furnace has changed greatly in the hands of designers. Beginning with the homemade oil-drum pattern, Fig. 14, it has been elaborated in various ways with convenient accessories and attachments, such as firebrick linings, drop-bottoms and sliding tops, Fig. 15. One feature of advantage in these caisson furnaces is that they may be lifted out and relined to any size of hole. The lifting hooks, or eye bolts, Fig. 11, are inserted into holes in the top flange and the crane does the rest.

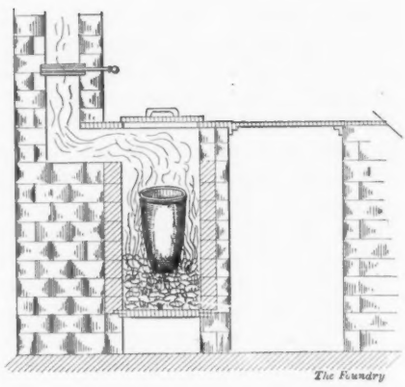


FIG. 13—OLD TYPE OF AIR FURNACE

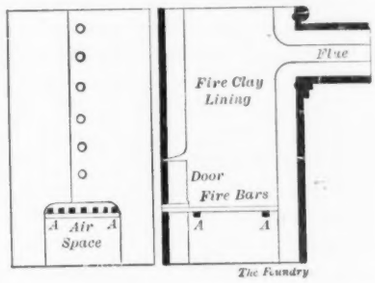


FIG. 14—EARLY TYPE OF OIL FURNACE

Lately the caisson has been turned into a horizontal pouring, oil injector furnace and the "converter" model of this type of furnace has become a great favorite, supplanting, in many cases, even the staid old reverberatory, which has always been considered the best furnace

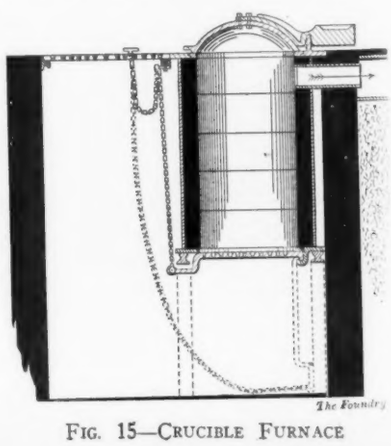


FIG. 15—CRUCIBLE FURNACE

for melting bronze in large quantities. If preferred, therefore, a series of four or five portable melting furnaces could be installed in lieu of the reverberatory and eight crucible furnaces shown.

On account of their compactness and high melting speed, these furnaces would occupy less space and work quite up to the required capacity. The next turn of the wheel is sure to bring along the much-to-be-desired, because clean, swift, convenient and economical, electric furnace for ordinary melting. Till then a great many of the jobbing brass founders may content themselves with the improved caisson furnace, the reverberatory, or the oil or gas ejector type.

Concluding this paper, it is probable that some more of the floor space might be saved by adopting an overhead tram-system instead of the standard floor track, but that is a matter which can very well be discussed when we come to complete the equipment.

MODERN METHODS OF MELTING METAL

A Discussion of the Introduction of the Oil Melting Furnace in the Brass Foundry—Handling Metal

AT THE November meeting of the New York Railroad Club, W. S. Quigley, of the Rockwell Engineering Co., discussed "The Brass Foundry—Modern Methods of Melting and Handling Metal." Intimating that the brass foundry has been neglected, he pointed out that this is in striking contrast with the equipment and operations of modern malleable and gray iron foundries. Even though the tonnage is smaller, the value of the product is often greater than that of any other metal melting plant, while the savings that may be effected are in direct proportion to the output. Continuing, he spoke in part as follows:

"There are many new brass foundries being erected, each with some improvement, but few are anywhere near the mark. The layout is generally haphazard, embodying local or pet ideas of the designer, but without any comprehensive plan being followed. The modern molding machine was the first real advance made, and should be credited with doing more to draw attention to the possibilities of improving the foundry than any other device.

Brass Foundry Inducements.

"Formerly the brass foundry held out little or no inducement for the progressive or technical man, the chances of making a name or advancing from the foundry to any important position being remote. How many superintendents of motive power or master mechanics and mechanical engineers today are thoroughly conversant with brass foundry practice, and do not rely entirely upon their foundry foreman for all information relative to his department.

"After the molding machine, the modern open-flame oil furnace—by that, I mean the tilting and revolving oil furnace in which the metal is melted in direct contact with the flame without the aid of crucibles.

"I think it best to here review the history of the oil furnace as it is known today. Melting the non-ferrous metals in the open flame is by no means new. Many large and successful foundries are using, and have used, open-hearth furnaces successfully for large work, but until the convenient revolving oil furnaces were introduced very little was known of this method of melting.

Introduction of the Oil Melting Furnace.

"Early in 1901, the Charlier and Schwartz furnaces were put on the market; the advantages quickly appealed to the foundrymen and they were sold indiscriminately on approval as fast as they could be manufactured to anyone who was willing to try them. The idea prevailed, both with the maker and consumer, that it was a case of "throw the metal in and the furnace will do the rest," without regard to foundry conditions, such as kind and quantity of metal used, heat at which it was required, nature of the work done and facilities for installing, handling the metal, etc., which should have been taken in consideration. In the city of Detroit alone furnaces were sold in the winter of 1902-3. This brought about a very unsatisfactory condition, as a great many failures were made, and as bad news travels very fast, much more was heard of the failures than of the successes. This proved the necessity of intelligent operation and of changing the foundry practice to meet the requirements of the new methods.

"The indiscriminate sale of the furnaces when first put on the market and the lack of knowledge regarding the operation caused much uncertainty in the minds of the foundrymen and doubt as to their real merit, so that it became necessary to sell on approval, subject to trial, and go through a long series of tests to prove the makers' statements before furnaces would be accepted.

"These preliminary tests have the good effect of setting a standard which, if the records are preserved, should act as a check to further careless operation.

"The oil furnace broke the old routine of three heats, and when the management grasped the situation and would adapt themselves to the new way, the molders were instructed to continue setting up molds until the mixture they were using was ready for them or their floor was to be poured.

To take full advantage of this a method of transporting the melted metal quickly, conveniently and economically to the mold is of importance. Very few foundries, so-called modern, which have excellent melting facilities, have given this matter much thought or worked out a comprehensive carrying system, which is almost, if not as important as the melting itself.

Overhead Tramrail.

For this purpose an overhead tramrail or trolley, located so that the metal may be poured directly from the melting furnaces into the ladles, and quickly propelled by one man or boy, and not carried laboriously and slowly by three or four men, to the floor where it is to be poured, should be installed. The tramrail should be placed so that the metal may be conveniently poured directly into the molds and easily moved from place to place. Some of the larger foundries have abandoned the old practice of the molder pouring his own work and now have one or more men who pour all the work, the molder making the molds only.

"This effects a natural saving by enabling the molder to devote his time exclusively to his work, thus increasing the output per molder. This applies also to machine molding. For floor molding and heavy and light work, quick-acting electric cranes are very efficient and should be a part of all up-to-date equipment."

FOUNDRY BLOWER PRACTICE*

Recent Developments in Fan and Blower Construction—Comparison of the Two Types—Melting Ratios

BY WALTER B. SNOW

MODERN foundry practice in the melting of metals is fundamentally dependent upon the blower. As the successor of the blowpipe and the bellows, it has made possible the massing of fuel in large quantities, with greater imposed resistance, the production of higher temperatures, and the better utilization of the heat in the furnace.

The primary function of a blower is to move air against resistance. Its performance is dependent upon the relation expressed by the formula:

$$V = \sqrt{2gh} \qquad [1]$$

in which V = velocity in feet per second
h = head in feet
g = acceleration due to gravity = 32.16

or $$V = \sqrt{2g\frac{p}{d}} \qquad [2]$$

when h is expressed in terms of p = pressure and d = density.

When applied under the conditions of
p = pressure in ounces per square inch
d = density or weight per cubic foot of dry air at 50 degrees Fahr. and under atmospheric pressure of 14.69 pounds or 235 ounces = 0.077884 pounds, formula [2] becomes

$$V = \sqrt{64.32 \times \frac{p \times 144}{16 \times 0.077884 \times \frac{235+p}{235}}} \qquad [3]$$

which reduces to

$$V = \sqrt{\frac{1746659 \times p}{234+p}} \qquad [4]$$

Allowance is evidently made therein for compression of air but not for change of temperature during discharge.

The velocities in the basis Table I were calculated by this formula.

The tabulated volume is in each case the produce of velocity and effective area.

The theoretical horsepower is the product of pressure, velocity and effective area.

For refined work, or under conditions of wide variation from the basis of the table, corrections should be made for differences in humidity and temperature.

In the ordinary processes of the foundry, where iron or the less refractory metals are to be reduced, the resistance of the crucible, air, or cupola furnace will roughly range from somewhat above one ounce to a possible but usually unnecessary pressure in excess of 20 ounces per square inch.

Up to about 8 ounces the fan blower cannot be excelled for convenience and efficiency. From 8 to 16 ounces the field is fairly divided between the fan and the rotary types, the advantage gradually shifting from the former to the latter as the pressure increases. Above 16 ounces the superiority of the rotary type is manifest until it in turn encroaches upon the efficient field of the blowing engine at about 5 pounds; a pressure far in excess of the practical requirements of the foundry. The air compressor, as an aid to combustion, is economically useful only in connection with the burning of liquid fuel.

Fan and Rotary Blowers.

The fundamental differences between the fan and the rotary type of blower lie in the manner of creating pressure and in the effect of resistance.

In the fan type, velocity is given to the air in its passage from the inlet to the circumference of the revolving wheel. This is transformable into pressure with corresponding density within the enclosing case and connections; the pressure being dependent upon the number of revolutions. In the case of a fan blower at constant speed, the volume and power decrease as the resistance increases. When the outlet is closed, the wheel continues to revolve at the same speed, but without effective delivery, and with minimum power expenditure.

In the rotary, or so called "positive" type, air in regularly succeeding volumes is imprisoned by one or more enclosed revolving impellers, and forced forward against the imposed resistance. It is thereby compressed to a density, and given a pressure proportionate to that resistance. This pressure is fundamentally independent of the number of revolutions. The delivery remains practically constant for a given speed as long as discharge is permitted, while the power expenditure increases with the resistance. When the outlet is closed, the power required is at the maximum, and the displacement, though ineffective, is just equal to the slip; up to the limit of power to drive and of strength to endure.

Design of Fan Blower.

The construction and proportions of a prevalent type of cupola fan blower are illustrated in Fig. 1. The casing and wheel are provided with two inlets, which, in ordinary construction, are about one-half the diameter of the wheel. The width of such a wheel at its periphery ranges from 5 to 8 per cent of the diameter, the width between the side plates at the inlet being approximately one-sixth of the diameter. From six to eight major blades extend from inlet to circumference; between these are one, two or three times as many minor blades of about one-half the radial length. All blades are slightly curved backwards at the circumference of the wheel. The cast iron casing is of involute form, its greatest diameter being approximately 1¾ times the diameter of the enclosed wheel.

In the volume type, designed for much lower pressures, such as are required in air furnace operation, the peripheral width of the wheel ranges from 20 to 40 per cent of its diameter. The casing is often of steel plate.

* Read at the annual meeting of the American Society of Mechanical Engineers.

Refined consideration of blower design is not necessary in a discussion of foundry blower practice, but a knowledge of fundamental principles and empirical relations is essential to a clear understanding of the subject.

The manufacturers' rating of the type of blower shown in Fig. 1 is based upon the greatest effective area over which it will maintain the maximum velocity of discharge. As originally established by Sturtevant, this "capacity area" or "square inches of blast" is represented by the empirical formula

$$\text{Capacity area} = \frac{DW}{3} \qquad [5]$$

in which D = diameter of wheel in inches

W = width of wheel at circumference in inches.

This formula was derived from the pressure type of fan blower. The value of the divisor must necessarily vary with the proportions of the wheel, the number of inlets, the number and curvature of the blades, and the form of the enclosing case. But as a merely arbitrary basis, the formula has been generally accepted for the ready comparison of wheels of substantially the same type.

Manifestly the maximum velocity of discharge will create the maximum total pressure. As a factor in the manufacturers' rating this attainable velocity has been accepted as being equal to the circumferential speed of the wheel. This assumption is by no means universally correct.

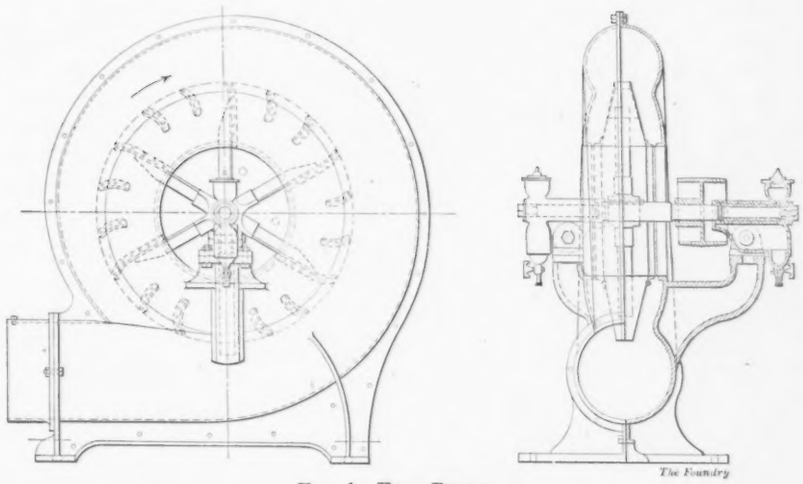


FIG. 1—FAN BLOWER

Recent Developments in Fan Construction.

Recent developments in fan construction with very large inlets, numerous shallow blades, and unusual width, show discharge velocities far in excess of the circumferential speed, approximating a theoretical maximum of twice that speed. But successful application of such fans has not yet been made under the resistance obtaining in cupola practice.

It is evident that, disregarding the effect of changes in density and temperature, the following relations should hold for a given fan with constant capacity area:

a the volume varies directly as the revolutions,
b the pressure varies directly as the square of the revolutions,
c the power varies directly as the cube of the revolutions.

These relations clearly point to the economic desirability of closely proportioning the fan to the work it is to perform. An increase of only 25 per cent in the speed, which may be necessitated by deficiency in the volumetric capacity of a given fan, nearly doubles the power required, and creates a pressure more than 50 per cent in excess of that at normal speed. It is seldom that the sum of fixed charges and operating expense cannot be materially reduced by substituting a larger and more costly fan for one that must be run at unnecessary speed to deliver the required volume.

Speed.

The speed of a fan is usually fixed, and variations occur only in the effective area of discharge. In cupola practice such variation is extensive, and changes often succeed each other with frequency. Hence it is difficult to proportion the fan to secure the most economical average performance.

For the ordinary type of fan it has been generally accepted that within the capacity area

a The velocity and pressure are maximum and constant.
b The volume and horsepower are proportional to the area.

These relations are only approximate, as is evident from Fig. 2. The curves are characteristic of an individual instance in which the fan ran at constant speed while discharging through various outlet areas. All values are relative to the performance at capacity area. Changes in the proportion or the speed of the fan would materially affect these relations, causing them to approach or recede from the conditions expressed in the preceding paragraph, and shifting the point of maximum efficiency.

These curves serve to show that

a Maximum efficiency in power and pressure are secured at or near the capacity area.

Table I.

RELATIONS OF PRESSURE, VELOCITY, VOLUME AND HORSEPOWER.

Pressure Per Sq. In.	Pressure Per Ozs.	Velocity of Dry Air at 50 Degrees Fahr. Escaping Into Outer System Through Any Shaped Orifice. Feet per Sec.	Feet per Sec.	Volume Discharged in One Minute Through an Orifice Having Effective Area of One Sq. In. Cu. Ft.	Horsepower Required to Move Given Volume Under Given Conditions.
1		86.03	5 161.7	35.85	0.00978
2		121.41	7 284.4	50.59	0.02759
3		148.38	8 902.8	61.83	0.05058
4		170.98	10 258.6	71.24	0.07771
5		190.76	11 445.5	79.48	0.1084
6		208.53	12 511.9	86.89	0.1422
7		224.77	13 486.4	93.66	0.1788
8		239.80	14.387.9	99.92	0.2180
9		253.83	15.229.6	105.76	0.2596
10		267.00	16 020.4	111.25	0.3034
11		279.70	16 768.1	116.45	0.3493
12		291.30	17 478.2	121.38	0.3972
13		302.59	18 155.2	126.06	0.4470
14		313.38	18 802.7	130.57	0.4986
15		323.73	19 423.6	134.89	0.5518
16		333.68	20 020.7	139.03	0.6067
17		343.26	20 595.8	143.03	0.6631
18		352.52	21 151.0	146.88	0.7211
19		361.46	21 687.8	150.61	0.7804
20		370.13	22 207.5	154.22	0.8412

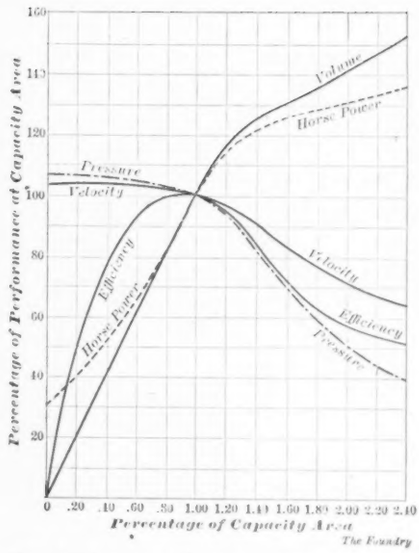


FIG. 2—RELATIVE PERFORMANCE OF A FAN AT CONSTANT SPEED WITH VARIABLE OUTLET AREA.

b The power per unit of volume and the pressure decrease as the discharge area and volume increase.

c With closed outlet the power is approximately one-third of that at capacity area.

From the preceding it must be manifest that no simple exact basis of calculation can be established for varying fan proportions and conditions. For all practical purposes, however, the manufacturer's basis, although only approximately correct, is sufficiently accurate.

Upon this basis Table II has been calculated to show the performance at capacity area per inch of peripheral width of typical diameters of cupola fan blowers. Basic values are taken from Table I, the air being dry, and of 50 degrees Fahr. temperature; the velocity of discharge is taken as equal to the circumferential speed of the wheel, and the power, as double the theoretical. While 50 per cent efficiency is below that which may be attained in good cupola installations, it is always desirable to provide ample surplus above the power required at capacity area. Even a change of 50 degrees from the ordinary inlet temperature makes a difference of about 10 per cent in the power.

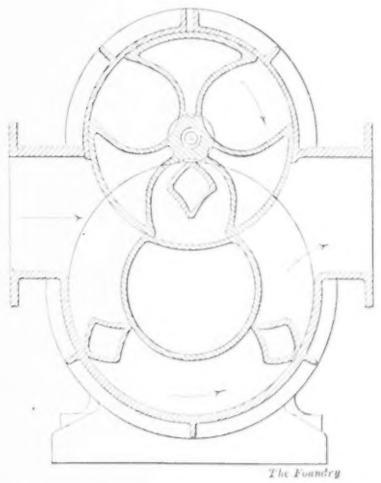


FIG. 3—ROTARY BLOWER, SINGLE IMPELLER, TRIPLE BLADED TYPE

Rotary Blowers.

Characteristic types of single and double impeller rotary blowers are presented in Figs. 3 and 4. Numerous other designs are, or have been, in use.

In the type shown in the skeleton cross-section in Fig. 2, the single impeller is made up of three diamond-shaped blades extending from a central web. On either side of the web a stationary core fills the space within the inner circumference of the blades, forming in connection with the enclosing case an annular space within which they revolve. The rotor which co-incidentally revolves in the smaller portion of the casing, successively provides pockets to receive and pass the revolving impeller blades to the suction side of the blower, without allowing the escape of compressed air. The rotor is in effect an idler which calls for no power expenditure other than that required to overcome friction.

In the type shown in Fig. 4, both impellers are symmetrical and counterparts of each other. The surfaces are so formed, and the impellers are so located on their respective shafts, as to permit of rotation with uniform clearance, and without metallic contact. Release of air on the discharge side of each impeller is practically coincident with the cut-off of admission on the inlet side.

In both types, the air passing through the inlet is imprisoned, and carried forward to the outlet side. Here it meets and mingles with an air of greater density, already compressed by previous action of the impellers. Equalization of pressure instantly results. As a consequence, there is more or less fluctuation coincident with the revolutions of the blower. The degree of fluctuation depends upon the ratio between the released volume and the total volume under compression, and also upon the extent to which the air has been previously compressed in transit through the blower. This occurs in the case of the single, but not of the double impeller type here illustrated.

The theoretical relations which prevail in the case of a rotary blower having a fixed free area of discharge and no slip, are identical with those already specified for the fan type operating within its capacity area, namely; the volume, and consequently the velocity, vary as the number of revolutions, the pressure varies as the square, and the power as the cube of the revolutions. But here the similarity ends, for in the fan the number of revolutions is an essential function of the pressure, while in the rotary blower they are entirely independent. In other words, material changes of total pressure with the fan type can only be secured within the capacity area by change in revolutions, while with the rotary type, great range in pressure is attainable, at constant revolutions by merely varying the resistance.

Under conditions of constant speed, and variable outlet or resistance, the performance relations of a theoretically perfect rotary blower are as follows, the effect of changes in temperature and density being disregarded:

Table II.

PERFORMANCE OF CUPOLA FAN BLOWERS AT CAPACITY AREA PER INCH OF PERIPHERAL WIDTH.

Diam of Wheel Inches / Cap. Area Sq. In.	Item.	Total Pressure in Ounces Per Square Inch. 6	7	8	9	10	11	12	13	14	15	16
18 in. 6 sq. in.	r.p.m.	2660.0	2860.0	3050.0	3230.0	3400.0	3560.0	3710.0	3850.0	3990.0	4120.0	4250.0
	cu. ft.	520.0	560.0	600.0	640.0	670.0	700.0	730.0	760.0	780.0	810.0	830.0
	h. p.	1.7	2.1	2.6	3.1	3.6	4.2	4.8	5.4	6.0	6.6	7.3
24 in. 8 sq. in.	r.p.m.	2000.0	2150.0	2290.0	2420.0	2550.0	2670.0	2780.0	2890.0	2990.0	3090.0	3190.0
	cu. ft.	700.0	750.0	800.0	850.0	890.0	930.0	970.0	1010.0	1040.0	1080.0	1110.0
	h. p.	2.3	2.9	3.5	4.2	4.9	5.6	6.4	7.1	8.0	8.8	9.7
30 in. 10 sq. in.	r.p.m.	1590.0	1720.0	1830.0	1940.0	2040.0	2140.0	2230.0	2310.0	2390.0	2470.0	2550.0
	cu. ft.	870.0	940.0	1000.0	1060.0	1110.0	1160.0	1210.0	1260.0	1310.0	1350.0	1390.0
	h. p.	2.8	3.6	4.4	5.2	6.1	7.0	7.9	8.9	10.0	11.0	12.1
36 in. 12 sq. in.	r.p.m.	1330.0	1430.0	1530.0	1620.0	1700.0	1780.0	1850.0	1930.0	2000.0	2060.0	2120.0
	cu. ft.	1040.0	1120.0	1200.0	1270.0	1340.0	1400.0	1460.0	1510.0	1570.0	1620.0	1670.0
	h. p.	3.4	4.3	5.2	6.2	7.3	8.4	9.5	10.7	11.9	13.2	14.5
42 in. 14 sq. in.	r.p.m.	1140.0	1230.0	1310.0	1380.0	1460.0	1530.0	1590.0	1650.0	1710.0	1770.0	1820.0
	cu. ft.	1220.0	1310.0	1400.0	1480.0	1560.0	1630.0	1700.0	1770.0	1830.0	1890.0	1950.0
	h. p.	3.9	5.0	6.1	7.3	8.5	9.8	11.1	12.5	13.9	15.4	17.0
48 in. 16 sq. in.	r.p.m.	1000.0	1070.0	1150.0	1210.0	1270.0	1330.0	1390.0	1450.0	1500.0	1550.0	1590.0
	cu. ft.	1390.0	1500.0	1600.0	1690.0	1780.0	1860.0	1940.0	2020.0	2090.0	2160.0	2230.2
	h. p.	4.5	5.7	7.0	8.3	9.7	11.2	12.7	14.3	15.9	17.7	21.0

a The volume is constant.
b The velocity varies inversely as the effective outlet area.
c The pressure varies inversely as the square of the outlet area, hence as the square of the velocity.
d The power varies directly as the pressure.

But the mechanical necessity of clearance, and the consequent slip or backward leakage, affect these relations particularly as the conditions depart from the field of maximum efficiency. The slip is theoretically, and in practice, approximately proportioned to the square root of the pressure difference between the atmosphere and the imprisoned air, that is, to the velocity which it creates. It therefore results that the volumetric efficiency decreases as the pressure increases.

Fig. 5 presents characteristic curves showing relative performance of a single impeller blower of the type illustrated in Fig. 3. The rapid drop in mechanical efficiency at pressures below one-half pound is manifest.

The performance of a two impeller type, like Fig. 4, at different speeds and resistances, is illustrated by the curves in Fig. 6. Volumes and horsepowers are relative.

Table III.

RANGE OF FERFORMANCE OF CUPOLA BLOWERS.

Diameter Inside Lining. In.	Capacity Per Hour. Tons.	Pressure Per Sq. In. Oz.	Volume of Air Per Min. Cu. Ft.	Horsepower.
18	0.25- 0.5	5- 7	150- 300	0.5- 1.5
24	1.00- 1.5	7- 9	600- 900	2.0- 6.0
30	2.00- 3.5	8-11	1 200- 2 000	5.0- 15.0
36	4.00- 5.0	8-12	2 200- 2 800	10.0- 23.0
42	5.00- 7.0	8-13	2 700- 3 700	12.0- 32.0
48	8.00-10.0	8-13	4 000- 5 000	18.0- 45.0
54	9.00-12.0	9-14	4 500- 6 000	22.0- 60.0
60	12.00-15.0	9-14	6 000- 7 500	30.0- 75.0
66	14.00-18.0	9-15	7 000- 9 000	35.0- 90.0
72	17.00-21.0	10-15	8 500-10 500	45.0-110.0
78	19.00-24.0	10-16	9 500-12 000	52.0-130.0
84	21.00-27.0	10-16	10 500-13 500	60.0-150.0

Comparison of the Two Types.

Under specific conditions of constant speed and resistance, it might be possible to establish the superiority of one type of blower above the other, based primarily upon first cost and operative efficiency. But conditions vary as do blowers, which for commercial reasons are built in stated sizes from which selection must be made. Hence the problem is complicated, and the solution becomes to a considerable degree dependent upon the intangible factor of "adaptability."

With no purpose of definition as to advantages or disadvantages, the characteristics of the two types operating within practical limits may be thus summarized and contrasted:

With a fan blower the maximum pressure is determined by the number of revolutions; with a rotary blower it depends upon existing resistance or the weighting of the relief valve.

The volume discharged by a fan blower is dependent upon the outlet area and the corresponding pressure; in the rotary type it is independent of both.

The maximum power is required when a fan blower discharges against the least, and when a rotary blower discharges against the greatest resistance.

The fan blower automatically increases the created pressure as the opposing resistance becomes greater, until it equals the maximum pressure capacity of the fan. The volume, although coincidentally decreased, is rendered effective by the greater pressure, while the power is roughly proportional to the effective work. The rotary blower is likewise automatic up to the limit of pressure temporarily established by the resistance of the relief valve, but without material change of volume, and with increase in power. Above the pressure limit set by the valve, air escapes to the atmosphere, and the power expended thereon has no useful effect.

The weight and cost of a fan blower are far less, and the speed far higher than in the case of a rotary blower; at low pressures the efficiency of the fan is superior while at the higher pressures necessary in the cupola, the rotary type excels.

As the total head or pressure created by a blower represents the sole means of producing movement of the air, whatever portion of this head is consumed in overcoming the frictional resistance of piping and fuel, reduces by just so much the amount remaining available for the production of velocity. The greater the ratio between the surface of a pipe, and the quantity, and the higher the velocity, the greater is the resistance.

Outlet.

Were the outlet in the casing of a fan blower to be made equivalent to the capacity area, the velocity and corresponding friction would be excessive. But in both the fan and rotary types, the area of the outlet is such that the velocity of discharge seldom exceeds 3,000 feet per minute. Even this is so great that material saving in power may be secured in a long pipe by making its area considerably in excess of the blower outlet. For instance, the frictional loss in 100 feet of 10-inch pipe with 3,000 feet velocity will be practically one ounce; while that in a 12-inch pipe, passing about the same volume at 2,000 feet velocity, will be approximate ⅜ ounce.

If a certain velocity pressure is required at the point of final delivery, it is manifest that the blower, if in a distant location, must create a total pressure sufficiently in excess to allow for the loss by friction. A drop of a couple of ounces is not uncommon with an ordinary piping system.

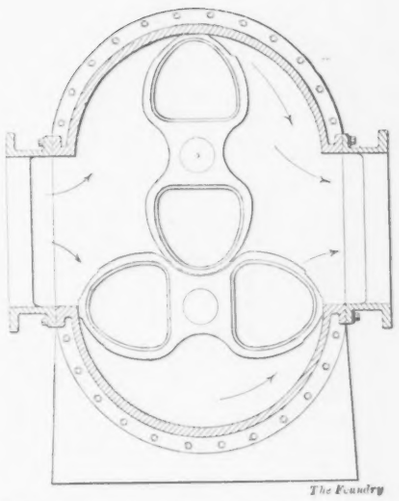


FIG. 4—ROTARY BLOWER, DOUBLE IMPELLER TYPE

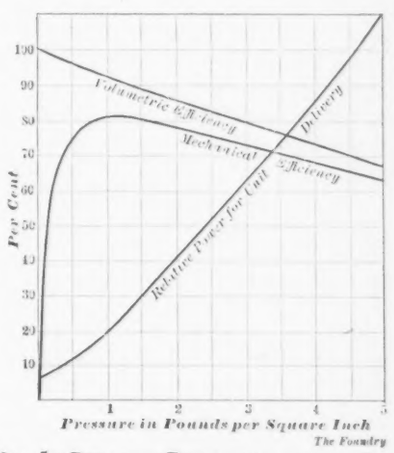


FIG. 5—RELATIVE PERFORMANCE OF A SINGLE IMPELLER ROTARY BLOWER AT CONSTANT SPEED WITH VARIABLE RESISTANCE

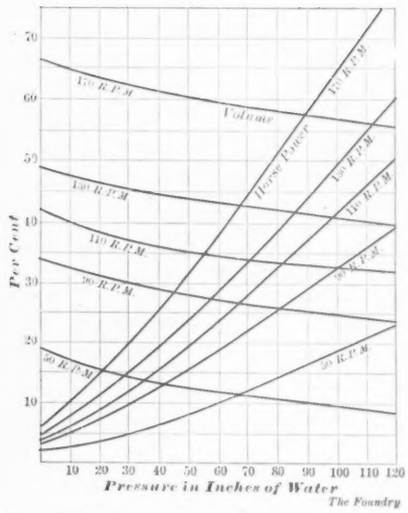


FIG. 6—RELATIVE PERFORMANCE OF A DOUBLE IMPELLER ROTARY BLOWER AT VARIOUS SPEEDS AND PRESSURES

Volume Determination.

The actual conditions in a conduit may be determined by a Pitot tube, and calculations of volume made therefrom. The most satisfactory form of instrument appears to be that devised by Mr. D. W. Taylor, and described in his paper before the Society of Naval Architects and Marine Engineers, November, 1905. Care must be exercised in the use of any form of pressure gage in order to avoid misleading readings. This is particularly true regarding determination of pressure in the wind-box of a cupola, wherein the direction of air currents is uncertain.

The modern cupola furnace is typical of metallurgical progress in which conservation of heat has been secured by massing fuel and metal.

It would at first appear that equal facility was provided for securing complete combustion, and that the quantity of air furnished might closely approximate the chemical requirements. But to secure the best results the volume is reduced in practice considerably below that theoretically required; of necessity incomplete combustion results. The conditions are closely similar to those in the blast furnace.

The reason for this condition is to be found in the arrangement of the superimposed charges of fuel and metal with relation to the air supply, which necessitates passing through the lower charges all of the air required for those above. Although perfect combustion with an excess of air is thereby secured in the melting zone, the tendency of excessive dilution is to cool the gaseous mixture to a temperature even below that of the molten iron. Under such conditions less heat is transferred to the upper charges, because of the higher velocity and lower temperature of the gases.

The air supply to a cupola is not, therefore, to be determined by the chemical requirements of the entire body of fuel, but by the excess which the lower charges are able to endure without disastrous cooling. The level of the ignition zone, and the completeness of combustion, are necessarily limited by this excess.

The introduction of two or more rows of tuyeres with large aggregate area, has served to distribute the air admission, to reduce the cooling effect in the melting zone, to raise the level of the ignition zone, and to perfect the combustion.

Gases.

Authoritative chemical analysis of the escaping gases are exceedingly rare, but such as are available show that only about 50 per cent of the carbon combines to form carbon dioxide. The balance escapes as an element of carbon monoxide having less than one-third of the heat value. In other words, only about two-thirds of the possible heat of combustion is utilized. This indicates a shortage of about 25 per cent in the air supply.

The intermittent operation of the ordinary cupola is not conducive to the ready utilization of the waste heat by external means, as is possible in the case of the blast furnace. Further economy is therefore to be sought within the cupola itself, and in the application of the blower thereto, presumably along the lines in which improvement has already been made.

The air supply to a cupola is usually expressed in cubic feet per net ton of iron melted. The amount necessarily varies with the melting ratio, the density of the charges, and the incidental leakage. Fair average practice is represented by the following:

					Per ton of iron.
6	lbs.	iron	per	lb. coke,	33,000 cu. ft. air
7	lbs.	iron	per	lb. coke,	31,000 cu. ft. air
8	lbs.	iron	per	lb. coke,	29,000 cu. ft. air
9	lbs.	iron	per	lb. coke,	27,000 cu. ft. air
10	lbs.	iron	per	lb. coke,	25,000 cu. ft. air

It is customary to provide blower capacity on a basis of 30,000 cubic feet, which corresponds to 75 or 80 per cent of the chemical requirements with average coke, and a melting ratio of 7.5 to 1. This is evidently ample for any higher ratio.

Obviously, neither the rate of combustion, nor the rate of melting, can remain constant under the varying conditions within the cupola. In fact, it is not fundamentally necessary that they should. But the blower is usually run at constant speed, and delivers uniform volume except as reduced by resistance.

As a rule this reduction, which occurs only in the case of the fan, is relatively slight, for the volume (of which the velocity is a function) var-

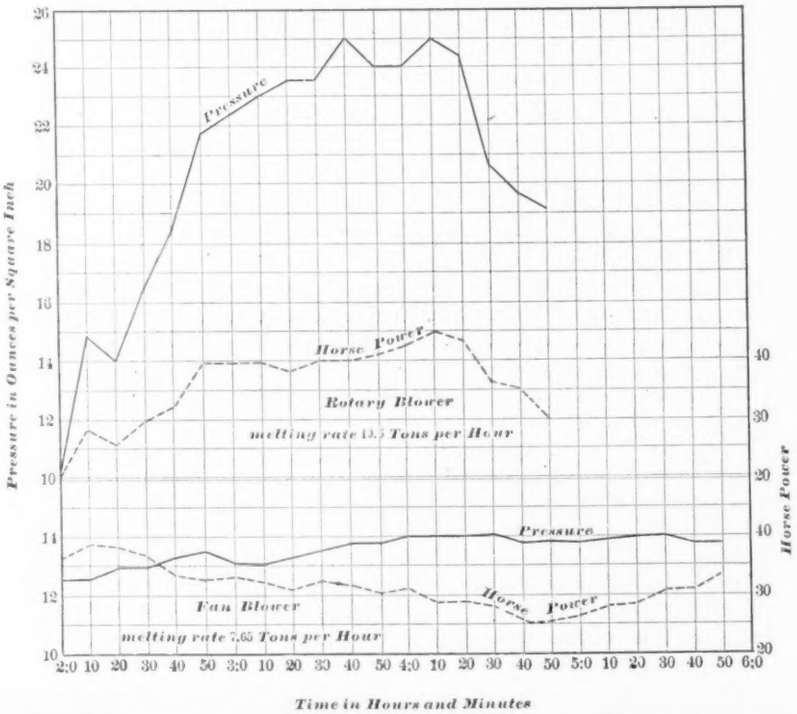


FIG. 7—PERFORMANCE OF FAN AND ROTARY BLOWER ON A 54-INCH CUPOLA

ies as the square root of the pressure. Hence, for instance, a 20 per cent drop in pressure entails only about 10 per cent loss in volume. Fairly constant pressure with a more regular, though not uniform volume, is therefore to be expected in fan blower cupola practice, as well as a moderate melting rate due to delayed combustion, resulting from reduction in air supply coincident with increase in resistance.

Resistance.

As ordinarily installed the resistance of a cupola will never exceed the pressure which a rotary blower can create if sufficient power is supplied. If no relief valve is provided, or it is set high enough to prevent escape, all air must be discharged through the cupola, hence the volume will be practically constant. As the pressure equals the resistance, considerable variation is to be expected during the heat, while, owing to the maintenance of uniform air supply, a more rapid rate of melting may be possible than with the fan.

These expectations are usually fulfilled in practice, although the contrast lessens as the proportioning of the blower to the cupola approaches the ideal. So far as the blower is concerned, its actual volumetric output, relatively to the cupola requirements, is the determining factor in the melting rate.

Operations Compared.

For the purpose of illustration, extreme contrasts between the operation of a fan blower and a rotary blower are graphically presented in Fig. 7. These curves are based on tests reported by Mr. H. E. Field at the December, 1904, meeting of the Pittsburg Foundrymen's Association. The blowers, a No. 10 Sturtevant fan and a 33-cubic-foot Connersville rotary, were installed for alternate use in connection with a 54-inch lining cupola. So far as possible the charges were alike in weight and character in both cases. The scrap was heavy, and of such shape as to pack closely. These tests will be made the basis for some pertinent comparisons.

Here are practically identical conditions of cupola and contents, but great contrasts in operation which show the effect of variation in air volume and pressure. With the fan blower the pressure was comparatively constant, the variation being between 12½ and 14⅛ ounces in the wind box with an average of 13.6. The net power ranged from 25 to 38.5 horsepower, with an average of 31.2. The pressure with the rotary blower varied through the extreme range between 10½ and 25 ounces, while the average stood at 20.63. The variation in horsepower was between 19 and 45, the average being 35.8.

With the fan 28.84 tons were melted in 3.77 hours, at the rate of 7.65 tons per hour, while with the rotary blower 2.82 hours were required to melt 31.5 tons, at an hourly rate of 10.6 tons, an increase of nearly 40 per cent in output. This reduces

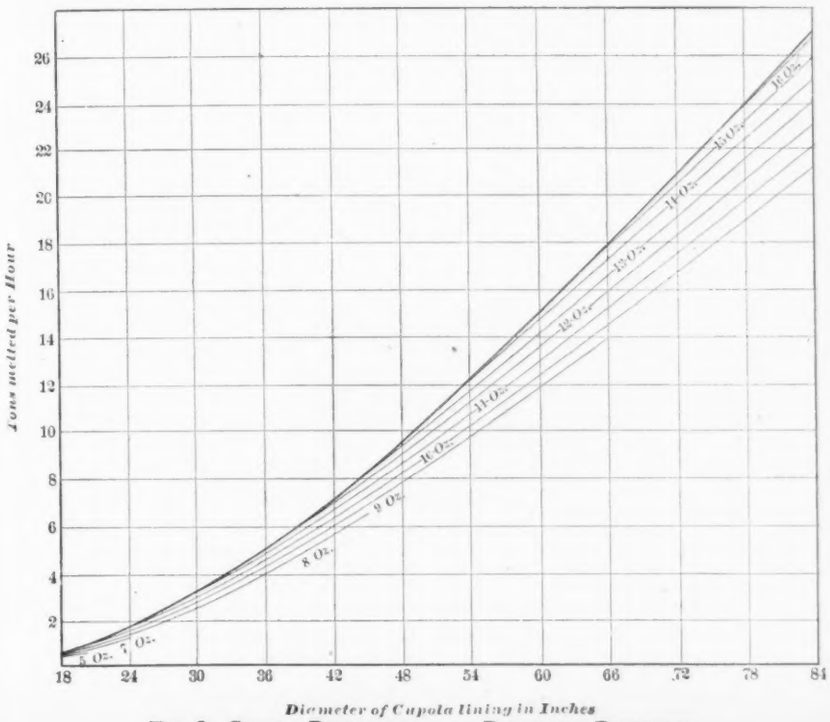


FIG. 8—CUPOLA PERFORMANCE AT DIFFERENT PRESSURES

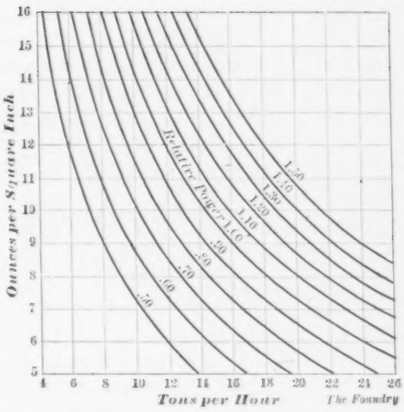


FIG. 9—ROTATIVE POWER FOR DIFFERENT PRESSURES AND MELTING RATES

to a net input of 4.09 horsepower per ton melted per hour with the fan, and 2.98 horsepower with the rotary blower; an apparent advantage of 27 per cent in favor of the rotary.

By far the larger quantity of air was discharged by the rotary blower, the rate of melting being closely proportional to the volume, as may be shown by a careful analysis of the tests. The rate is low for the size of the cupola, extremely so in the case of the fan, and is in part at least the result of excessive resistance presented by large pieces of scrap.

The results shown by these tests emphasize the possible effect of changes in the relation of the blowers to the cupola. Had the rotary blower been of smaller capacity such excessive pressures would not have been necessary to force the constant volume through the cupola; the power would have been decreased, and the duration of the heat prolonged, with probable decrease in the horsepower hours per ton. Had the fan been run at higher, but not excessive, speed, to permit of passing a larger volume, which it was fully capable of delivering, the horsepower would have increased, the time decreased and the power per ton per hour would certainly have more closely approached that required by the rotary blower.

Another Test.

A subsequent unofficial, but credible, test made upon the same cupola equipped with a No. 8 Sturtevant fan presents an instructive contrast. The conditions were identical with those in the previous tests, except that a small amount of very light scrap was charged. The results showed 9.41 tons melted per hour with an average pressure of 12.5 ounces and a power expenditure per ton per hour less than 80 per cent of that required with the No. 10 fan.

The preceding renders manifest the difficulties in the way of exactly proportioning blowers to the somewhat unknown conditions of their work, and likewise the futility of attempting to base comparisons of ultimate efficiency upon such limited experiments. In contrast thereto, it can be shown that a No. 10 Sturtevant fan, upon a 60-inch cupola, regularly melted 13.8 tons per hour, with an expenditure of 2.6 horsepower per ton, and a No. 8, upon a 42½-inch, required only 2.9 horsepower per ton upon a total output of 6.46 tons per hour. And likewise that rotary blowers of identical size and quality have shown results both inferior and superior to those here reported.

The higher speed of melting, which because of its ability to overcome excessive resistances, may be maintained by the rotary blower, is universally recognized, as is also the increased time thus rendered available for molding before the first iron is tapped. But the greater pressure incident to the higher rate is much more severe in its cutting effect upon the lining, while the value of the time gained for molding depends upon individual foundry conditions. The superior mechanical efficiency of the rotary type is, to a greater or less degree, offset by much lower first cost and fixed charges on the fan. The necessity of providing power capacity greatly in excess of the average in the case of the rotary blower is not to be overlooked. Neither is it to be forgotten that the brief duration of the heat reduces the difference in annual expenditure for power to a relatively unimportant item. For instance, under the exceptional conditions in the tests shown in Fig. 7, the daily difference in electrical horsepower hours input was only 20.3. On a basis of 10 hours per day this equals only two horsepower continuously exerted.

Melting Ratio.

Theoretically, for otherwise constant conditions, the following relations hold for cupolas and melting rates within the range of practical operation:

a The melting rate with constant volume varies directly as the square of the diameter, that is, as the cross sectional area of the cupola, and directly as the volume, as the square root of the pressure, and as the cube root of the power for a given cupola.

b The volume varies inversely as the square of the cupola diameter for a given melting rate, and directly as the melting rate for any cupola.

c The pressure with a given cupola varies directly as the square of the volume, that is, as the square of the melting rate, and as the depth of the charges for a given melting rate.

d The power with a given cupola varies directly as the cube of the melting rate, and as the cube of the square root of the pressure, and directly as the pressure for a given melting rate and any cupola, i. e., inversely as the fourth power of the diameter for a given melting rate.

e The power per ton per hour (the operating efficiency) for a given cupola varies directly as the square of the melting rate, that is, as the pressure; and for a given melting rate directly as the rate for a given pressure, directly as the pressure and inversely as the fourth power of the diameter.

f The duration of the heat for a total output for a given cupola varies inversely as the square root of the pressure.

These relations might well be the source of numerous formulae for practical use were it possible to establish accurate coefficients. But the great variety in cupolas, tuyerage proportions, and character of fuel and iron, to say nothing of the difference in charging practice in different foundries, or even the variety in the same foundry, are bewildering and discouraging. Maximum efficiency in a given case can only be assured after direct experiment. But something short of the maximum is usually accepted in ignorance of the ultimate possibilities. But even though subject to some variation under working conditions, the preceding relations point clearly to the factors that make for maximum efficiency. It is obvious that pressure and melting rates should be as low, and cupola diameters as great as practical considerations will allow.

High Pressure.

High pressure is a relic of small tuyere area. The tendency is distinctly in the line of more moderation, both because of higher ultimate operating efficiency, and the improved quality of the castings.

Figs. 8 and 9 clearly indicate the economy of such a course. It is to be noted that although the curve of maximum output in Fig. 8 is freely drawn through points representing good current practice, it conforms closely to the relations expressed above, i. e., that the melting rate varies directly as the square of the diameter. Wide variations are to be expected in individual cases. The maximum pressures capable of maintaining the corresponding melting rates under proper conditions vary with the diameter and the height of the cupola, as well as with the proportions of the charges. Other melting rates are plotted in proportion to the square roots of lesser pressures for corresponding cupola diameters.

Low Pressure.

The power economy of low pressures and melting rates is clearly shown by Fig. 9. The lines of unit expenditure have been arbitrarily fixed in the middle field of good practice.

The actual melting range of a cupola is ordinarily between 0.6 and 0.75 ton per hour per square foot of cross section. The limits of air supply per minute per square foot are roughly 2,500 and 4,000 cubic feet, with the mean as representative of fair practice. The possible power required varies even more widely, ranging from 1.5 to 3.75 horsepower per square foot, corresponding respectively to 2.5 and 5 horsepower per ton per hour for the melting rates specified above.

Current practice can only be expressed between limits as in the case of Table III. Therein is given the ordinary range of the different variables for stated cupola diameters. The specified pressures prevail most extensively in recent installations. In so far as it is possible to determine the melting rate and the necessary pressure therefor, the power may be roughly calculated, from the theoretical requirement of 0.27 horsepower to deliver 1,000 cubic feet per minute against 1 ounce pressure. The power increases directly with the pressure, and is practically dependent upon the efficiency of the blower. This will range from 50 to nearly 70 per cent in a good fan installation, and up to a possible maximum of 90 per cent with a first-class rotary blower equipment. The drop in pressure due to an extended system of piping must not be neglected in such calculations.

The trend toward lower pressures in the cupola is reflected in currrent air furnace practice. The high pressure fan blower with small volumetric capacity has been superseded by the volume fan having ample capacity at much lower pressure.

Both volume and pressure are dependent upon the quality of the coal and the rate of combustion. The deep fire lends itself to complete utilization of the air supply, with minimum excess and maximum temperature. Both under and over grate supply pipes should be of ample size to avoid excessive loss by friction, and the pressure should be the lowest which, with a properly proportioned blower, will pass the required volume. This pressure need not exceed 2½ ounces per square inch, and under good conditions should be considerably less. The volume delivered beneath the fire may be kept well down toward the theoretical requirements, not exceeding 200 to 225 cubic feet per pound of coal.

In the crucible furnace still lower pressures prevail but the air supply is not as effectively utilized.

METALS IN FOUNDRY PRACTICE

Questions from Practical Foundrymen are answered
in this department by the following experts

CAST IRON . . . . . W. J. KEEP
MALLEABLE IRON . . . . . DR. RICHARD MOLDENKE
METALLURGY OF STEEL . . . . . J. B. NAU
STEEL CASTINGS . . . . . W. M. CARR

OTHER EXPERTS ALSO CONTRIBUTE ADDRESS ALL INQUIRIES TO THE EDITOR

CAST IRON NOTES

BY W. J. KEEP

GREAT care should be exercised in the selection of the various grades of pig iron used when making semi-steel. It is customary to experiment until the best brand offered in the local market is found. For example, one of the original promoters of semi-steel, who sold a flux or "medicine," used only one kind of pig iron, and when asked to substitute another brand was obliged to experiment and was never able to do as well as with his favorite brand.

No. 3 pig should never be used, as the silicon and carbon are too low. To make sound semi-steel castings the iron should be very hot and silicon is required for this purpose. This element should never be lower than 2.25 per cent nor higher than 2.50 per cent. By investigation it was soon ascertained that the flux contained aluminum, and that pure aluminum was better than the medicines offered and was substituted for these secret concoctions. By its use the iron is made fluid and blow holes are eliminated. It is not advisable to use boiler plate clippings. Scrap structural steel cut into lengths of about 8 inches can be used to advantage. The clippings oxidize and adhere to the sides of the cupola and one cannot ascertain how much gets into the castings. The following are two semi-steel mixtures which gave good results.

No. 2 Crozier, 1,600 pounds; steel scrap, 600 pounds; McDowell alloy, 7½ pounds.

Three test bars 1 inch square and 12 inches long broke at 3,100, 3,250 and 3,300 pounds respectively, with deflections of 1/12 inch, 1/10 inch and ⅛ inch.

The analysis of the No. 2 iron used was as follows: Carbon, 3.25 per cent; silicon, 2.60 per cent; phosphorus, 0.71 per cent; sulphur, trace; manganese, 0.97 per cent.

Another mixture was made up as follows: No. 2 Pulaski, 1,400 pounds; steel scrap, angles, 600 pounds; ferro-manganese, 80 per cent, introduced in the ladle, 5 pounds; 1 block of aluminum, 2 inches by ½ inch, introduced in the ladle.

A test bar, 1 inch square and 12 inches long, broke at 3,000 pounds. This mixture showed a quarter inch chill. The analysis of the pig was as follows: Silicon, 2.20 per cent; phosphorus, 0.28 per cent; sulphur, 0.022 per cent; manganese, 0.72 per cent.

This mixture was quite hard.

The mixtures generally used in that foundry were as follows:

First—Pulaski iron, 1,400 pounds; steel angles, 600 pounds.

Second—Pulaski iron, 1,500 pounds; steel angles, 500 pounds.

Third—Pulaski iron, 1,600 pounds; steel angles, 400 pounds.

The second mixture was about right. The chill test was made by casting against a heavy chilling surface, a test piece 1¼ inches thick and 4 x 4 inches on the flat surface, with the edge against the chill. The chill of the second mixture was 3/16 inch deep and the silicon in the casting was about 1.50 per cent. The secret of making sound semi-steel castings is to have the iron hot and fluid. Remelted semi-steel is not satisfactory. The strength is largely due to the mechanical mixture of the steel with the cast iron, and by remelting the mixture is completed and the metal has a tendency to become brittle. Remelting increases sulphur, and semi-steel absorbs this element freely, much more so than gray cast iron, as the carbon and silicon are decreased by the mixture of the steel. Accurate records of mixtures and strength should be kept, and by experiments the best proportions can be found.

IRON MIXTURES FOR VALVES.

Question:—We are having trouble with our iron for small cylinders weighing from 300 to 1,000 pounds. Our mixture is made up of No. 2 pig, 800 pounds; No. 3, 1,200 pounds. The No. 2 pig contains 2.30 per cent, and No. 3 1.60 per cent silicon. The sulphur in each is 0.026 per cent and the manganese is 0.83 per cent. The phosphorus in No. 2 is 0.50 and in No. 3, 0.25 per cent. Do you believe that if this iron were melted and poured into chills and remelted good cylinder iron would be secured? What would be the effect on the wearing qualities? Is there any way I can harden 200 or 300 pounds of iron taken from a mixture carrying 2 per cent silicon? I wish to cast Corliss valves and I want them very hard and close grained.

Answer:—The first mixture would have about 1.88 per cent silicon. It should be a very fair cylinder mixture. If the grain is too coarse, add good machinery scrap until the mixture is satisfactory. It would certainly be poor economy to remelt and cast in chills, although this is sometimes done and will close the grain. A better way is to use suitable scrap, and if you desire a very hard wearing surface for valves, lay a chill in the mold and run the wearing surface against it. With such iron as you describe the chill will be very thin, and soft enough for the tool to take hold.

In answer to the second question, it is better to use for the first cupola charge just such a mixture as you desire because you will not be able to get the iron hot enough to melt a sufficient quantity of any iron in the ladle to harden it. If you can melt about 2 per cent of spiegeleisen in the ladle it will harden the iron, but considerable difficulty will be experienced in melting it.

SEMI-STEEL.

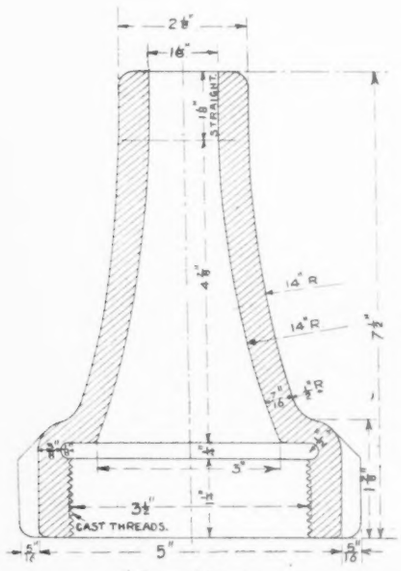
Question:—We are having trouble with our semi-steel castings, which develop blow holes after being finished. Our mixture is as follows: 800 pounds No. 2 pig iron; 1,000 pounds No. 3 pig iron; 200 pounds steel boiler plate clippings. We use a small amount of ferro-manganese in the ladle. The analyses of the irons are as follows: No. 2, silicon, 2.29 per cent; sulphur, 0.027 per cent; phosphorus, 0.051 per cent; manganese, 0.83 per cent. No. 3, silicon, 1.60 per cent; sulphur, 0.026 per cent; phosphorus, 0.27 per cent; manganese, 0.84 per cent. Our coke contains 0.83 per cent sulphur.

Answer:—Do not use ferro-manganese, but use sufficient pure aluminum to prevent blow holes. Begin with 1 ounce of aluminum in the ladle for every 100 pounds of iron and then vary the amount as needed.

TO CAST IRON AGAINST A CHILL.

Question:—We are endeavoring to cast the nozzles shown in the accompanying illustration so that they will not have to be finished on the inside, which must have a perfectly smooth surface. We would also like to know of a method by which the threads could be cast on the castings. We have been trying to chill the surface, but have not secured good results.

Answer:—It is extremely difficult to cast such a fine thread. The iron would shrink if cast against the chill and would crack and furthermore, the chill would not last very long. In addition, the castings would not all shrink alike and threads of different diameters would result. Such threads are, however, being cast successfully by the Cast Thread Fitting Co., of Seneca Falls, N. Y., by a secret process which is the result of considerable experimenting. Use an iron chill for the inside of the core and paint the chill with red phosphorus dissolved in kerosene. The usual coating would be plumbago mixed with kerosene and painted on, or you might make an oil core from any fine sharp sand which should result in a smooth and true interior. You might try a threaded chill painted with phosphorus as the base for the core and unscrew it before the red hot iron begins to shrink.



IRON NOZZLE

OVER-ANNEALED MALLEABLE CASTINGS.

BY DR. RICHARD MOLDENKE

Question:—We are having some difficulty with malleable castings which appear to be partially annealed, notwithstanding the fact that the material can be bent and twisted. Our hose clamp castings have the appearance of being thoroughly annealed, but show a white band. The analysis of our castings is as follows: Silicon, 0.676; phosphorus, 0.198; manganese, 0.50; sulphur, 0.041. In bending the castings they break short, even when the fracture shows a distinct white band. We are using a particularly good grade of Youghiogheny coal for smelting, the sulphur averaging less than 1 per cent.

Answer:—Your castings have the appearance of being slightly overannealed. The composition is correct, except that the manganese is too high. This always causes difficulty in annealing. The manganese should be down to 0.20 or below in the castings. The white band shown in the fracture of the hose clamp is not objectionable and the pin ends are good, with the exception of one, while the remainder are over-annealed. This, however, does not mean that the heat is too high, but that the metal could not stand it, for one or the other of the following reasons: Either the proportion of pig was too great in the mixture, leaving the structure too open, or else the metal was partially burned in the melting by being permitted to remain in the furnace too long. This results in oxidation and causes trouble in annealing owing to the fact that the metal is not able to withstand high temperature without the penetration of oxidizing influences sufficient to redissolve the carbon. From the sample sent it can be readily seen that the castings were annealed all right, but that the annealing was carried too far. The structure of the hard castings or unannealed piece is quite different from the structure of the piece which was left in the fire too long. The latter has the appearance of dirty, burned steel. The former has the crystalline structure of white iron. The solution of your difficulties will be dependent on your melting, and every effort should be made to see that the metal gets out of the furnace rapidly before it becomes oxidized. Then it will withstand the annealing temperature without showing evidence of overheating.

USE OF YELLOW BRASS

BY C. VICKERS

Question:—We accumulate a large amount of yellow brass turnings, and while all of our castings are made of red brass and are very light, we are at a loss to know how to use this yellow brass to advantage. In making our castings, we find that the metal is hard to run, is stiff and sluggish and does not flow as freely as red brass. We also experience considerable difficulty in machining it, as the particles adhere to the drills and wear off the edges very quickly. We would like to know of a way that we might use this yellow metal to advantage.

Answer:—A good way to use up yellow brass turnings in this case would be to mix them with the red brass, using them in place of zinc. Take for example a mixture of copper 12 pounds, zince one pound. To replace the zinc with yellow brass, figure that the yellow brass contains two-thirds copper. Three pounds, therefore, will introduce one pound of zinc and two of copper, so we can add one more pound of yellow brass, making the mixture 12 pounds of copper and four pounds of yellow brass, which is near enough for all practical purposes. On this basis you can figure your mixture so as to use up all your yellow scrap, bearing in mind that the yellow brass will not hurt the red mixture even if you do get in a little more than would be strictly necessary to replace the zinc.

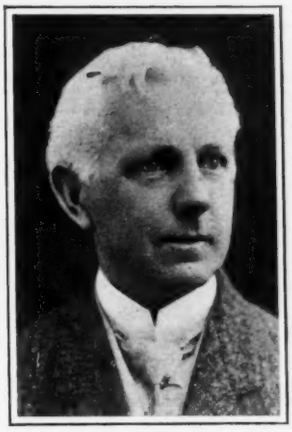
WHITE METAL MIXTURES.

A cheap white metal can be made by mixing 1 pound of antimony and 9 of tin. Another mixture consists of 1 pound of tin and 1 pound of copper melted together and melt 1 pound of this mixture for 15 pounds of tin and 18 ounces of antimony. Do not get the mixture too hot.

MECHANICALLY TREATED MOLDING SAND*

Latter-Day Method of Mixing Sand for the Foundry and Core Room—Centrifugal Machine

BY ALEXANDER E. OUTERBRIDGE JR.



IT IS NO exaggeration to say that foundry practice, in this country at least, has been revolutionized within the past 25 years through the substitution of scientific for empirical methods. The relation between the chemical composition and physical properties of metallic alloys used in founding—thanks to the pioneer investigations of Prof. Turner and others—is now very generally known, and practical application is made of this knowledge in all modern plants.

Next in importance to the various metals of which castings are made, if not indeed of equal importance therewith, must be classed the material of which the molds and cores are composed. Strange to say, there is comparatively little literature dealing with this important topic in a scientific way and that little is found in technical magazines and in the proceedings of the engineering societies. It remains for some one to collate the facts and to present them in a form available to the founder.

Treatment of Molding Sand.

The writer having been invited to contribute a paper to a symposium upon the subject of molding sand and its treatment will confine his remarks to the practical side of the question and endeavor to show how greatly molding sand, including core sand, can be improved in its physical properties by correct mechanical treatment; and at the same time, how the cost of preparation of the sand for molds and cores can be greatly reduced as compared with the old-fashioned methods that are still in vogue in many establishments.

In the effort to prevent costly "wasters" in the foundry, which sometimes wipe out the estimated profit on some specific jobs, the composition and physical properties of the different varieties of molding sand used in the foundry of William Sellers & Co., Inc., Philadelphia, first became the subject of careful study by the writer more than 15 years ago.

The selection of sand suitable for all purposes in the foundry constituted at that time a not unimportant part of the duty of the very competent foundry foreman.

It was found on looking into the matter that the only tests—if tests they could be called—which were then made of new sand were two in number and exceedingly crude in kind, one being for "toughness," a most important, indeed essential property, the other for "porosity."

Archaic Tests.

The expert's test for toughness consisted simply in squeezing a handful of the sand into the form of a ball and then breaking it, little or no attention being paid, by the way, to the degree of dampness or the more or less heterogeneous composition of the sand. The porosity test consisted, in like manner, in compressing gently a small quantity of the sand between the palms of the hands and then blowing through it. While such tests may seem absolutely absurd in their crudity it must be admitted that in the hands of an expert they afford a fair degree of practical knowledge of the average quality of the molding sand.

In order to improve, if possible, on these time-honored methods of testing sand, the first plan devised was to make a number of test bars of "green" sand, 6 by 1 by 1 inches, under uniform conditions of pressure, dampness, and quantity of material used in forming the molds. These little test bars were placed upon a smooth metal plate with sharp and square edges. The bars were then pushed over the edge of the plate, until they broke, when the amount of the "overhang" was measured. It was soon found that there was a great difference in the length of the overhang, which was regarded as a quantitative measure of toughness of the sand; these differences were not even noticeable by the crude ball test.

Samples taken from different parts of a small heap of sand that had been uniformly dampened or "tempered," varied greatly in this respect, owing, no doubt, to the irregular distribution

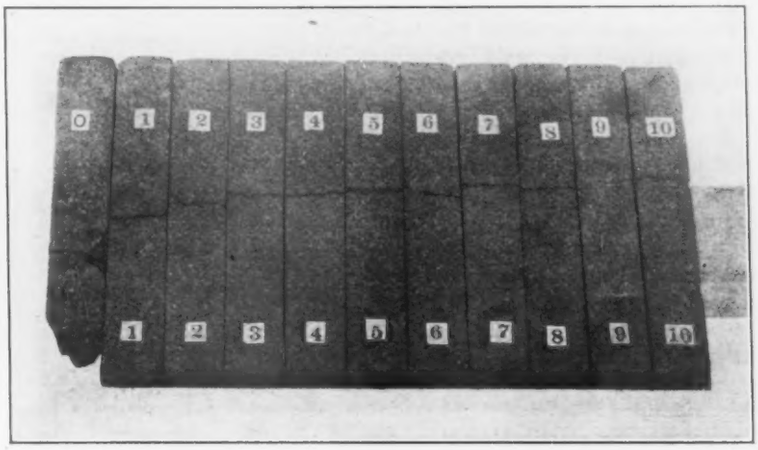


FIG. 1—GREEN SAND TEST BARS MADE FROM ONE SAMPLE OF SAND

*Presented at the annual meeting of the American Society of Mechanical Engineers.

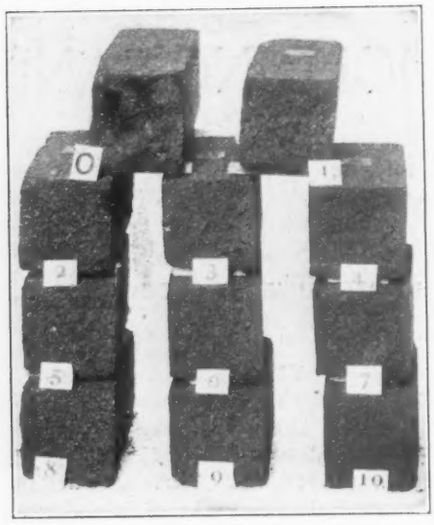


FIG. 2—FRACTURED SURFACES OF GREEN SAND TEST BARS

of the alumina or clay binder, and the correctness of this inference was subsequently confirmed by simple analytical tests.

Improved Tests.

After a sufficient number of these test bars had been made and broken to prove reliability of the method, further tests were devised to ascertain whether the usual methods of riddling and mixing sand for the molder's use affected its quality either by increasing or decreasing its toughness, as shown by the amount of overhang of similar test bars of green sand. It was proved that the more thoroughly the sand was worked the greater the overhang, due as already stated to the more uniform distribution of the binder.

Ideal Molding Sand.

The ideal molding sand is a material in which the individual grains of silex, constituting approximately 90 per cent of the mass, are completely covered with an overcoat of alumina or clay, and the more uniform the grains are in size and shape the better is the sand with respect to porosity in relation to the average size of the grains.

It was found on passing a sample of sand a number of times through a hand riddle and making test bars from the sample after each riddling that the overhang was increased measurably. Thus, a sample of sand which, after tempering and mixing by hand with a spade, showed an overhang of less than 2 inches of the test bar, increased to nearly 3 inches after a dozen riddlings.

It would not be practicable to treat large masses of sand in this manner, even though a positive and valuable gain in the quality of the sand should be demonstrated by making test molds from patterns having considerable overhang in places, or in making fine-toothed gear wheels, etc., nevertheless the information thus obtained was quite valuable and led to important practical results, as will be seen presently.

Another novel observation was concurrently made, viz., that the increase in toughness and porosity noticed in these tests might be partly due to "aeration," or to the separation of the grains of sand when falling from the sieve to the floor. In order to discover the truth or falsity of this view a quantity of the sand was shaken in a box with a closed lid for seven minutes, and test bars were made before and after shaking, the correctness of the theory was quickly shown for the shaking without sieving proved to be more effective than the sieving without shaking.

Tests For Porosity.

Tests for porosity alone were also made, but as these were not very satisfactory, owing possibly to want of suitable means of accurately controlling and measuring the amount of air drawn through a mass of sand compressed in a tube, these tests were not prosecuted to a conclusion.

About this time William Sellers & Co., Inc., began to experiment with a centrifugal machine for mixing sand, and it was found that the desired result could be obtained with such a machine much more expeditiously and economically than by any treatment with riddles or chasers in a rolling mill, and at the same time, the toughness and the porosity were increased to a very much greater degree than was possible by the old methods. These satisfactory results led to further experiments in this direction that culminated in the development of a thoroughly practical centrifugal machine, simple in design and substantial in character, which proved so valuable in the foundry that it was placed on the market, and a large number are now in regular use in some of the largest establishments in the country as well as in many smaller foundries.

The machine is truly remarkable both as a labor saver and as an improver of molding sand. It accomplishes as much work by the help of two laborers in preparing molding sand as five men could do in 10 hours by the old method. Before proceeding to describe the machine itself, attention is called to the illustrations Figs. 1 and 2 showing tests made with facing sand for large and medium work before and after treatment by this new process.

Strong and Fine Sand.

There are three grades of molding sand in addition to core sand regularly prepared and used in the Sellers foundry for the different classes of work. They are classified under the names "Strong Sand," "Special Strong Sand" and "Fine Sand."

The strong sand is used for the majority of the large molds, such as planer beds and uprights, etc., and for the principal parts of other large machine tools. Most of these molds are skin dried, or baked on the surface, by means of a portable drying oven after having been "wet-blacked."

The special strong sand is used only for molds for the heaviest castings, such as large anvil blocks, etc., these molds are also wet-blacked and when baked on the floor are almost as hard as a stone or as hard as a

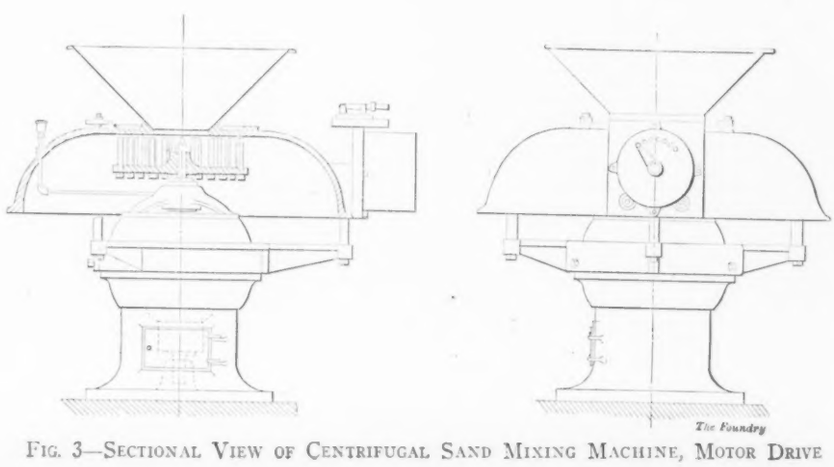


FIG. 3—SECTIONAL VIEW OF CENTRIFUGAL SAND MIXING MACHINE, MOTOR DRIVE

baked loam mold; this mixture is all new sand.

The fine sand is used for all light castings and much of the "medium" work; these molds are not baked and constitute what are commonly called green sand molds.

Sand Mixtures.

It may be interesting to know the formulae for the preparation of the three grades of molding sand given below:

STRONG SAND.

Strong Lumberton sand	(new)	=	14 parts
Gravel	(new)	=	7 parts
Floor sand	(old)	=	6 parts
Coal dust		=	2 parts

SPECIAL STRONG SAND.

Strong Lumberton sand	(new)	=	9 parts
Gravel	(new)	=	14 parts
Coal dust	(new)	=	2 parts

FINE SAND.

Weak Lumberton sand	(new)	=	14 parts
Fine floor sand	(old)	=	4 parts
Coal dust		=	2 parts

Fig. 1 shows 11 bars (6 by 1 by 1 inches) made from strong sand under uniform conditions of quantity, temper (dampness) and pressure of sand. The bar labeled 0 was pressed from a sample of the sand after having been dampened and turned over several times with a spade and only partially mixed; the object of such preliminary mixing is simply to prevent the coal dust from flying out of the centrifugal machine on subsequent treatment. The other bars were made from the same pile of strong sand after passing through the centrifugal sand mixing machine from one to ten times. These bars were all laid side by side upon the smooth metal plate (about ¼ inch thick) resting upon a table, and they were slowly pushed over the edge of the plate until they broke.

It will be observed that the first treatment increased the overhang three-quarters of an inch, the subsequent treatments increased the overhang in some cases one-quarter of an inch, and in some cases not measurably. The first treatment was, therefore, the most effective, and for practical purposes, one treatment is often sufficient to insure good mixing of the materials and thorough disintegration of any lumps. It may be stated that the machine is not designed to remove nails, jaggers, or stones. If the sand contains such things it should be put once through a very coarse screen to remove them before passing into the centrifugal machine.

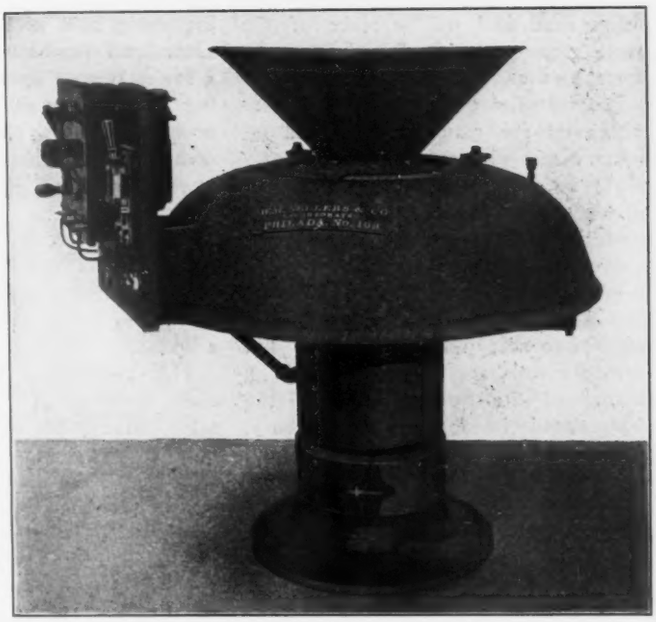


FIG. 5—CENTRIFUGAL SAND MIXER DRIVEN BY ENCLOSED ELECTRIC MOTOR

The following table gives the measurements of the overhang of each bar as nearly as the somewhat irregular shape of the break permitted:

No. 0	Length of overhang	=	2¼ inches
No. 1	Length of overhang	=	3 inches
No. 2	Length of overhang	=	3¼ inches
No. 3	Length of overhang	=	3⅜ inches
No. 4	Length of overhang	=	3½ inches
No. 5	Length of overhang	=	3½ inches
No. 6	Length of overhang	=	3½ inches
No. 7	Length of overhang	=	3⅝ inches
No. 8	Length of overhang	=	3⅝ inches
No. 9	Length of overhang	=	3¾ inches
No. 10	Length of overhang	=	3¾ inches

The strain tending to break the sand beam is increased by the additional weight of the increasing length of the overhanging portion and also by the increased moment of its center of gravity; it is readily seen, therefore, that an increase in length of the overhang of three-quarters of an inch on the first treatment in the centrifugal machine means an increased tenacity of 75 per cent; in like manner an increase in overhang of 50 per cent means an increase in strength of sand of 225 per cent. The illustration Fig. 2 shows the fractured surfaces of the same bars.

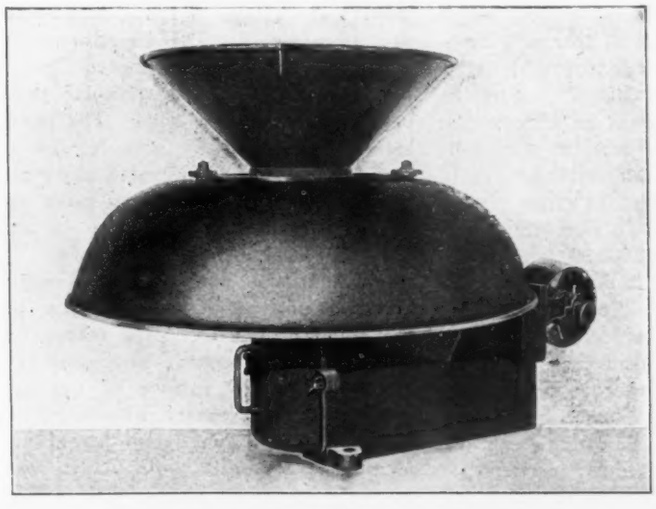


FIG. 4—CENTRIFUGAL SAND MIXER, BELT DRIVEN

Fractured Surfaces.

Bar No. 0 shows the heterogeneous components of the partly mixed sand, while the other fractures show increasing uniformity due to more thorough mixing and disintegration of lumps of gravel, up to No. 3, after which no further increase in uniformity is observable to the eye.

The illustrations convey a very fair impression of the actual appearance of the bars. The appearance of the fractured surfaces coincides with the tests for overhang and shows that a single treatment in this machine is, in many cases, sufficient, and two treatments are all that are usually needed with any sand mixtures.

In mixing core sand containing flour, the effectiveness of this centrifugal method is still more strikingly evident owing to the almost total disappearance of the white flour due to its thorough commingling with the sand and black coal in one treatment.

The tests here shown are typical of many others of similar nature that have been made, but to give a detailed statement of these would extend this paper beyond the desired limits.

Cores.

In recent years there has been a remarkable reduction effected in the cost, skill required, and time consumed in making cores by the use of

sharp sand and oil in place of the usual core sand mixed with flour or other binders.

The oil sand cores require no ramming and are made by unskilled labor; cases almost without number might be cited where the actual cost of cores has been reduced by the oil sand method from 50 to 75 per cent and over, and better results obtained in the foundry, with fewer wasters caused by the breaking down or "blowing" of cores; no venting and but few core rods are needed. Thorough mixing of the linseed oil with the sharp sand is absolutely necessary, though rather difficult to obtain and in accomplishing this the centrifugal machine is pre-eminent; in fact, it would be impossible without this machine to produce the remarkable results that are now daily recorded with oil sand cores in the foundry.

Centrifugal Mixer.

The centrifugal machine is, of course, equally well adapted to the thorough mixing of core sand with the various core oils and core compounds that are sold for making cores.

Experience has shown that in mixing sharp said with oil for cores, the centrifugal machine should be run at a lower rate of speed than when mixing and at the same time tempering ordinary molding sand. Two treatments are sufficient to insure thorough mixing of sharp sand and oil for oil cores.

In conclusion, it will suffice to give a very brief description of the Sellers' centrifugal sand mixing machine, two types being shown, together with a sectional drawing.

The centrifugal sand mixing machine consists of a rapidly revolving table, having on its upper surface a number of prongs arranged concentrically. The sand is fed into the hopper at the top of the machine, from which it falls upon the revolving table and is thrown by centrifugal force from prong to prong and out against the inside of the cover or hood. It emerges from beneath the hood in a fine shower, free from lumps and thoroughly mixed.

The table, spindle, spindle pulley, and bearings are enclosed in the housing or base upon which the machine stands, so as to protect effectually these parts from sand and dust.

A removable door is placed at the front of the housing to afford access to the spindle and bearings for cleaning or lubrication. The hopper can be lifted off for convenience of cleaning the prongs or removing stones, nails, etc., which do not pass between them.

The high rate of speed at which the table revolves, from 800 to 1,200 revolutions per minute, causes the sand to be tossed with much force from prong to prong, thus breaking up agglomerated lumps of gravel or clay, insuring not only complete disintegration but a degree of mixing not attainable by any other method. Every portion of sand is thoroughly "combed out," and analytical tests have shown the uniformity of mixture of heterogeneous compounds after passing twice through this little machine.

Fig. 4 shows a machine arranged to be driven by belt over the carrier pulleys at the back of the housing to the pulley on the table spindle.

Fig. 5 shows a machine driven by an electric motor enclosed within the housing where it is thoroughly protected from sand, dirt, etc.

TITANIUM IN STEEL AND IRON*

BY CHARLES V. SLOCUM

I PROPOSE to give briefly the result of a few experiments and some little investigation concerning the improvement to both steel and iron by the use of an alloy in the shape of ferro-titanium. This is an alloy which in the opinion of many of the best known metallurgists (some of whom I will quote later) is destined to revolutionize the manufacture of the more important grades of steel and iron. By more important grades I would classify not only crucible or tool steel but steel rails, shafts for steamships, steel tires, chilled iron car wheels and all products where possible breakage involves the probable loss of human life. I am sanguine on the subject not only because of the results already obtained from the use of the titanium alloy, but because the presence of titanium in high percentages in immense deposits of iron ore in mountain masses and in almost absolutely pure state as rutile or titanic acid, will inevitably make the price so low eventually as to be a mere secondary consideration.

In 1902 I bought some ten tons or so of American rutile which was not only guaranteed 90 per cent pure titanic acid but an analysis which I had made in Pittsburg after the material arrived showed that it actually ran as high as 96 or 97 per cent pure.

Ores High in Titanium.

The iron ores of the Adirondack range contain high percentages of titanium while many of the ore deposits of Virginia, North Carolina and some other states, as well as in Canada, Nova Scotia, Norway, Sweden, etc., are impregnated with it.

The U. S. Geological report of 1897-8, Part III, gives an idea of the inexhaustibility of ores in the Adirondacks high in titanium, and more than 750,000 tons of ore were shipped from that region this year and more than 1,000,000 tons are booked for shipment during 1908 from the same locality. Near Three Rivers, Canada, is a deposit of bog ore which contains considerable titanium and is remarkable in that it is stated that only six years are required for it to renew itself; i. e., you can dig out the ore today from a certain spot and in about six years the sluggish waters will have left another deposit in the same spot ready to be mined again.

Noticed a Peculiarity.

It was about the year 1890 that the St. Thomas Car Wheel Co. of St. Thomas, Ont., noticed a peculiarity in certain car wheels which it had been making for the Michigan Central railroad. It was unable to grind the wheels on the tread although the corundum wheels were identically the same as it had been using right along, and the hubs bored out quite freely. The superintendent stated that the wheels bored "more like cheese," i. e., less granular than usual and in no way hard. The president of the company, who resided in Buffalo, was much interested and went to St. Thomas purposely to make an investigation. He afterward wrote our Mr. A. J. Rossi as follows: "I found that the quality of the emery wheels being used was fully up to the standard but for some reason or another it was almost impossible to grind the chilled surface of the car wheels with the emery wheels. This obtained to such an extent that I remember one wheel on which the grinding machines ran for half a day without being able to make any impression to speak of. * * * We obtained extraordinary mileage from

*Presented at the November meeting of the Pittsburg Foundrymen's Association.

wheels made at the time at St. Thomas and now have at the shops there an engine wheel which made nearly 200,000 miles and from which not one-eighth of the chilled surface all around was worn." After careful investigation this unusual wearing quality was traced to one of the irons used which had been made from titaniferous ores.

It was about 1895 that the New York Car Wheel Works, which controlled the St. Thomas Car Wheel Co. mentioned, sent for Mr. Rossi and arranged to have him smelt a quantity of titaniferous ore, building for the purpose, under the superintendence of my brother, A. W. Slocum, a small blast furnace with a capacity of 3 or 4 tons per day, and in this diminutive but positive and definite manner several hundred tons of ore high in titanium were smelted.

The iron obtained was a remarkably strong gray pig, made principally to demonstrate that titaniferous ores could be readily smelted in the ordinary way if given proper attention and a proper flux, and the demonstration was entirely successful.

Rossi at Niagara.

Some three years ago or so Mr. Rossi went to Niagara Falls and built a small electric furnace for the purpose of experimenting in smelting titaniferous ores with electricity to obtain ferro-titanium and was successful in making over three hundred heats, necessarily small ones under the circumstances, but a number of tons of the alloy were made and samples from the same were sent to different manufacturers and institutions for experimental purposes; for instance, to Wm. Cramp & Sons, Abendroth & Root, Girard College, etc. I succeeded in getting some of it for the Keystone Car Wheel Co. at West Homestead.

The only objection to the alloy which we found was that it was then made in thick flat lumps about the shape of an apple pie but thicker. Eventually I sent a man to break some of it into small pieces to use in the ladle. He returned in the course of an hour saying that he was unable to break it. This was interesting, so with my brother, who was an athlete, and a couple of strong "husky" laborers, we hammered that lump of inoffensive titaniferous pie with a 20-pound sledge until we were tired, but only succeeded in polishing or smoothing it slightly where the blows struck. It was necessary to use several blows of our wheel breaker—a weight of 2,400 pounds falling 18 feet—before we succeeded in our purpose. I may add that we have made some of the alloy recently which we could not break and had to remelt it. The results obtained in the experiments were remarkable to say the least.

Increased Strength.

On test bars measuring one inch square by 12 inches between supports the transverse strength of a strong mixture averaging about 3,000 pounds breaking strain was increased to 3,600 pounds or 20 per cent by using only half of one per cent of the alloy which in turn contained 10 per cent of titanium, while a weak mixture made purposely for the experiment, which had a transverse strength in the test bar of 2,100 pounds, was increased to 2,950 pounds, or 40 per cent, by adding the same amount of alloy. Mr. Wm. Cramp wrote Mr. Rossi that the addition of titanium to their cast iron has shown an increase of 29½ per cent over their other cast iron, and of 4 per cent over their cast iron treated with nickel.

A large steel company, whose name I am not authorized to mention at present, had one of these lumps of titanium alloy weighing about 100 pounds when it received an order for a large steel shaft to replace a broken one for an ocean going steamer. This lump of alloy was thrown in whole in the hope of overcoming difficulties which had been had with blow holes and uneven shrinkage. The shaft came out clean and smooth, very strong, and turned up beautifully, and the steamer was promptly sent on its way carrying what might be termed a successful experiment with ferro-titanium.

Pencils for Electric Lamps.

The Adams Bagnall Co. of Cleveland, a large manufacturer of electrical equipment, is using quantities of titanium in making the pencils for the electric lamps because of the more brilliant flame obtained for their lights and the greater durability given them, a new field for titanium, but their rights are already covered by patents. It is claimed these pencils give four or five times as much light and last three times as long as the old style.

Titanium heated in oxygen creates an instantaneous dazzling flame like lightning. Wohler expresses the belief that there is no other known body which burns so energetically in oxygen gas.

It is commonly accepted that chrome, nickel, molybdenum and tungsten add certain qualities to metal, but none of these elements combines with nitrogen. Moissan says the combination of titanium with nitrogen gas is attended with the evolution of heat, that "it is the only indisputable example of the combustion of an element in nitrogen."

M. LeChatellier, professor of metallurgy in the Paris School of Mines, University of France, in his paper read at the last congress of metallurgists, held in Belgium in 1905, with some 1,600 delegates, recommended the treatment of all steels with ferro-titanium for the purpose of purification of the metal. "The presence of nitrogen to the extent of 0.02 to 0.045 or even 0.035 in certain steels being enough to cause the metal to break asunder, destroying all elongation and reduction of area."

Stable Nitride Formed.

Dr. F. C. Weber, of Chicago, says: "Titanium introduced as an alloy at once combines with the gaseous nitrogen present in the molten metal, forming a stable nitride. It is the formation of this stable nitride which prevents the formation of blow holes and thereby produces solid ingots or castings. The pipe is very much smaller and flat, not an inverted cone because the metal being freed from free oxide and slags is more liquid, not pasty, which greater liquidity permits a more perfect subsidence in the mold or flask during the cooling down to the freezing point of the metal."

Dr. Weber also says. "This very effective and simple cleansing of molten iron or steel makes a gray cast iron of a quality very near to that of soft steel. It makes a Bessemer steel of a quality nearly equal to crucible steel, while crucible steel is itself improved by it in every way." In a recent circular the latter part of this quotation was erroneously attributed to Mr. Rossi, and I make public apology for the error, which was my own.

Rossi's Work.

Mr. Rossi's work in investigating the merits and uses of titanium is so marked that to quote him would seem almost superfluous. Anyone making researches today concerning the qualities and effects of titanium cannot fail to be impressed with the vast amount of work he has done in connection with it or relating to it in blast furnace and cupola practice; in electric smelting and in the chemical laboratory, and last though not least the large amount of literary work involved in recording and placing before scientists and the world in general the results of his labors.

PUBLISHED MONTHLY BY
THE PENTON PUBLISHING CO.
CLEVELAND
BUFFALO.....932 Ellicott Sq.
CHICAGO.....1362 Monadnock Blk.
CINCINNATI.....First National Bank Bldg.
NEW YORK.....90 West St.
PITTSBURG.....521 Park Bldg.
DULUTH

Copyright, 1907, by Penton Publishing Co.

The subscription price of THE FOUNDRY is $1.00 a year in the United States and Mexico. To Canada, $1.50. To Great Britain, Eight Shillings. Single copies, 15 cents each. Change of advertising copy must reach this office on the 10th of the month preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

Practical articles pertaining to the trade in all its branches are solicited, and will be paid for.

When sending articles be sure to place your name and address on the article and on the drawings.

Entered as second-class matter at the Post-Office at Cleveland, Ohio.

CONTENTS.

The Manufacture of Cast Iron Pipe. 149
Method of Gaging the Thickness of Patterns 156
Rumbling Castings 162
Vanadium in Auto Cylinders..... 162
Patterns for Repetition Work..... 163
The Converter vs. The Small Open-Hearth—II. 169
A New Solder for Aluminum..... 170
Specifications for Iron and Fuel..... 171
Trolley Wheels 173
Imaginary Difficulties 173
A Foundry for Bench Work..... 174
A Jobbing Brass Foundry—II..... 176
Modern Methods of Melting Metal.. 179
Foundry Blower Practice..... 180
Notes on Semi-Steel..... 187
Iron Mixtures for Valves..... 187
To Cast Iron Against a Chill..... 188
Use of Yellow Brass..... 188
White Metal Mixtures..... 188
Mechanically Treated Molding Sand. 189
Titanium in Steel and Iron..... 192
Trade Outlook 194
Regulation of Foundry Conditions... 194
Personal 195
A. F. A. Convention..... 195
Obituary 195
Recording Thermometers for Core Ovens 196
Charging Floor Crane..... 196
Gas Producer for Skin Drying Molds 196
Trade Notes 197
Trade Publications 198
Oven for Drying Small Cores..... 198
General Industrial Notes..... 199

Trade Outlook

As a result of the money stringency that has prevailed throughout the country during the past few weeks, many foundries have temporarily ceased operations, while others have curtailed their output from 25 to 60 per cent. Inability to secure funds to meet current obligations and wholesale cancellations of orders has resulted in the existing conditions in the foundry trade. Notwithstanding the decline in the demand, the disturbance is primarily financial, rather than commercial. The cause of the existing distrust is one of the perplexing problems of the situation, in view of the unbounded prosperity that has prevailed throughout the country. The fact that there has been no accumulation of stocks foreshadows a rapid recovery of trade in all lines as soon as financial conditions relax. The requirements of the west and northwest are greater than at any time in the country's history, and the construction work now under way will continue as funds are available. The bountiful crops harvested this year insures heavy sales for the products of the agricultural implement makers, upon whose prosperity the malleable branch of the foundry industry is so largely dependent. The railroads must continue to purchase castings, and while their requirements of new rolling stock may be curtailed, nevertheless a tremendous tonnage is required to replace worn out and broken parts. Automobile builders are temporarily withholding shipping instructions for brass and aluminum castings, but cancellations have not been numerous, despite contrary reports. Periods of depression are constructive and cleansing. Business generally is placed on a safer basis, and unsound institutions are the greatest sufferers. Notwithstanding the unparalleled era of new construction and extension from which the foundry trade is now emerging, it is gratifying to note that there have been few recent failures, and while a few concerns may be in distress, the condition is only temporary. This indicates that the foundry business is on a sounder financial basis than ever before, and is the forerunner of phenomenal future development. The sharp curtailment of iron production has not been followed by a proportionate decline in values, although in the absence of buying, prices are merely nominal, and lower quotations than those prevailing would undoubtedly be made on orders for large tonnages. Heavy losses will be sustained by foundrymen if the furnace operators insist upon the delivery of iron unshipped on existing contracts, as the selling prices of all classes of castings have declined. Although the cost of producing iron in recent years has rapidly increased, nevertheless the record quotations that prevailed throughout the summer months were out of all proportion with productive costs. It would be safe to assert that the present cost of manufacture is less than $14 a ton at lower lake ports, and not above this sum in the Mahoning and Shenango valleys. In the south, where iron was produced at a profit at $7 a ton some years ago, a fair average today is $11 a ton, and stacks inadequately equipped can not produce profitably at less than $12. A further decline from existing iron quotations is anticipated by the foundry trade, and until a fair level of values is reached, no buying movement of importance will develop in this branch of the industry. The decline in the prices of non-ferrous metals has been followed by a fair volume of buying and the placing of large contracts has been recently recorded.

Regulation of Foundry Conditions

The past few years have witnessed many additions to the factory and health inspection laws of the various states. While some of these may appear somewhat radical, and in cases more or less unfair to certain interests, yet as a whole such legislation has been reasonably sane, and the results salutary. In many states legislation has been unusually explicit in relation to the maintenance of proper sanitary conditions in foundries. In fact the foundry appears to have been singled out from other manufacturing developments or industries. Thus in Massachusetts the law passed in 1905 requires that

"The proprietor of every foundry engaged in the casting of iron, brass, steel or other metal, and employing 10 or more men, shall establish and maintain, except in cities or towns where to do so would be impracticable by reason of the absence of public or private sewerage or of any running water system, toilet room of suitable size and condition for the men to change their clothes therein, and provided with wash bowls, sinks, or other suitable set appliances connected with running hot and cold water, and also a water closet connected with running water and separated from the said toilet room. The said water closet and toilet room shall be connected directly with the foundry building, properly heated, ventilated and protected, so far as may be reasonably practicable, from the dust of the foundry."

The enforcement of this law is left in the hands of the state inspectors of health, a body of men of unusual ability for this service. By a recent enactment these men are appointed directly by the governor, and placed under the control of the state board of health. The law provides that they shall be practical and discreet, "learned in the science of medicine and hygiene," and that each man hold office for five years. All inspectors at present in service are regular graduate physicians. They are fully authorized to enforce all the factory sanitation laws. To a considerable degree these laws have been the result of careful investigations and reports of the State Board

of Health," which has studied industrial conditions in a remarkably practical way. They recognize that the most efficient and just method of improving the conditions of the working people in each of these industries would be to require those proprietors who carry on their work with little provision for health of their employes to make such provision as is made by those who provide the best. This is the most practicable method of bringing about improvement of existing conditions where necessary, and of encouraging those employers best disposed to improve still further the conditions regarding the health of all employed. As a result of extensive investigation they reported that machine shops are generally found to be in fair, and most of them in very good condition. The departments connected with foundries, including casting, scaling, cleaning and smoothing, grinding and polishing, involve exposure to extreme heat, fumes and dust, which may be very injurious to the workmen. The extent to which the workmen are protected varies greatly in different establishments; but there are many where the protection is very satisfactory, and it is desirable that others be brought up to their condition. The same may be said of the brass and iron foundries. Under the law, and subject to enactment by the inspectors, any factory employing five or more persons must be ventilated so that the air will not become so impure as to be injurious to the health, and that when necessary a fan or other mechanical means shall be employed to secure proper ventilation. A special law was passed some years ago which specifically relates to the operation of emery and buffing wheels or belts, and compels proper hooding and exhausting. Pure drinking water, medical and surgical chests, cleanly toilet facilities and the like are also required by law to be provided by manufacturers. The foundry sanitation law has now been in force for a sufficient term to judge of its merits. Although some objection to this act was presented prior to its passage, the inspectors have encountered no special difficulty in or opposition to its enforcement. They have almost universally found a willingness to meet the requirements, and a recognition of the prevailing improvement in all conditions which surround the workman. Even the molder himself is participating in this enlightenment, the pail is giving way to the washbowl; cleanliness is displayed in all the surroundings. In their investigation the Board of Health visited numerous foundries in the state. Of 14 iron and steel foundries seven showed generally poor conditions as to light, ventilation and dust removal; one showed commendable conditions throughout; the others, classed as good, were reasonably well equipped, lighted and ventilated. Of nine stove foundries, four presented moderately bad, and one distinctly bad conditions, while one is referred to as having conditions which may be regarded as sanitarily ideal. The specifically bad foundry employs 275 men, in low-studded, poorly lighted, unventilated buildings, in which there is no attempt to remove the dust arising from the processes of polishing and buffing by hoods and exhaust ventilation. In the tumbling room the dust is so thick that objects a few feet distant cannot be clearly distinguished. Many men refuse to work in this establishment during the hot months, on account of the excessive heat and general discomfort. Fortunately such conditions do not represent the average. Entirely aside from the law and the inspector, there is a definite trend toward voluntary improvement of working conditions. The welfare movement as a business proposition, entirely devoid of sentimentalism or paternalism, has been slow to make its way in the foundry. But from a standpoint of monetary returns, the value of healthful surroundings is now generally recognized. The critical work of inspection is decreasing, the law is becoming of less importance in the public eye, because of the lessening number of offenders against it.

PERSONAL.

James F. Webb, assistant foreman of the Lake Shore & Michigan Southern shops at Elkhart, Ind., and president of the Associated Foundry Foremen, has resigned to accept the position of superintendent of the new foundry that has recently been built by the Davenport Locomotive Works, Davenport, Ia.

Geo. L. L. Davis, formerly in charge of the New York office of the General Castings Co., has been appointed manager of sales for the railway supply department of the U. S. Metal & Mfg. Co., 25 Broad street, New York.

R. F. Barker, superintendent of the foundry of the Hill Clutch Co., Cleveland, has resigned.

Henry Gauerman has been appointed general manager of the Braddock Foundry & Machine Co., Braddock, Pa., to succeed W. F. Lewis, resigned.

R. S. Cornelius, of Grand Rapids, Mich., has been appointed general manager of the Wolverine Brass Works, Chatham, Ont.

George A. Gallinger has been appointed manager of the Pittsburg office of the Independent Pneumatic Tool Co., Chicago. A complete line of "Thor" pneumatic tools and spare parts are carried in this office, which is located at 1210 Farmers' Bank building.

PHILADELPHIA FOUNDRY FOREMEN.

At the November meeting of the Philadelphia Foundry Foremen, D. M. Kittinger, of the Pencoyd Iron Works, was elected secretary to succeed W. P. Cunningham, who declined a renomination. The other officers reelected were as follows: W. A. Perrine, president; H. A. L. Springer, vice president; and George M. Benkert, treasurer. George W. Ellicott, of the Southwark Foundry & Machine Co., and Thomas G. Smith, of the Midvale Steel Co., were elected trustees.

A. F. A. CONVENTION.

At a meeting of the executive board of the American Foundrymen's Association, recently held in New York, the invitation of the Canadian foundrymen to meet in Toronto next year was accepted. The convention will be held during the first week in June as heretofore. The Canadian members of the society are already making arrangements for the entertainment of the visitors.

OBITUARY.

John S. Rowell, founder and president of the John S. Rowell & Sons Mfg. Co., Beaver Dam, Wis., died recently, aged 83 years. He was one of the early settlers of Beaver Dam and many years ago began the manufacture of farm implements in a small plant from which the present extensive business has developed. Mr. Rowell was connected with other important industries of Beaver Dam and at one time served the city as mayor. Two sons, Theodore B. and Samuel W., are connected with the company of which their father was president.

Chas. H. Deere, president of Deere & Co., plow manufacturers, Moline, Ill., died in Chicago, Oct. 29, aged 70, after an illness of several months. He was born in Vermont and removed to Moline with his parents when a child. After completing his education, he entered business with the firm of Deere & Co., of which his father was the founder. In 1868 he became vice president and general manager, and since the death of his father has been president of the company.

FLUX FOR BRAZING CAST IRON.

A good flux for brazing cast iron consists of boric acid, one pound; pulverized chlorate of potash, four ounces; carbonate of iron, three ounces. When brazing the metal should be carefully cleaned and the flux should not be applied until the sections to be brazed have reached a bright red heat.

FOUNDRY & PATTERN SHOP EQUIPMENT

Recording Thermometer for Core Ovens—Charging Floor Crane—Gas Producer for Skin Drying Molds—Core Oven

THE RECORDING thermometer shown in the accompanying illustration has been installed in several of the plants of the American Steel Foundries by the Bristol Co., Waterbury, Conn. They are used for recording the temperatures of core ovens to insure a uniform temperature and to prevent the burning of cores.

By the use of this instrument the temperatures throughout the baking operation are shown, and the fact that the record is made automatically

BRISTOL RECORDING THERMOMETERS FOR CORE OVENS

causes the operator to exercise greater care in firing and the saving of fuel is considerable. The bulb of this instrument is made of copper, is 10 inches long, and may be placed at any point in the oven, being connected to the recorder by 25 feet or more of flexible metal tubing. It is advisable to locate the recorder at some convenient point for observation and it should be attached to the wall or some other convenient support.

The charts made by the thermometer are 8 inches in diameter and are changed daily. Instruments can be furnished for recording temperatures ranging from 40 to 600 degrees Fahr., or from 40 to 800 degrees Fahr. These instruments can also be equipped with electric alarm contacts that will ring a bell when temperatures rise above, or fall below, the points required to insure sound cores.

CHARGING FLOOR CRANE.

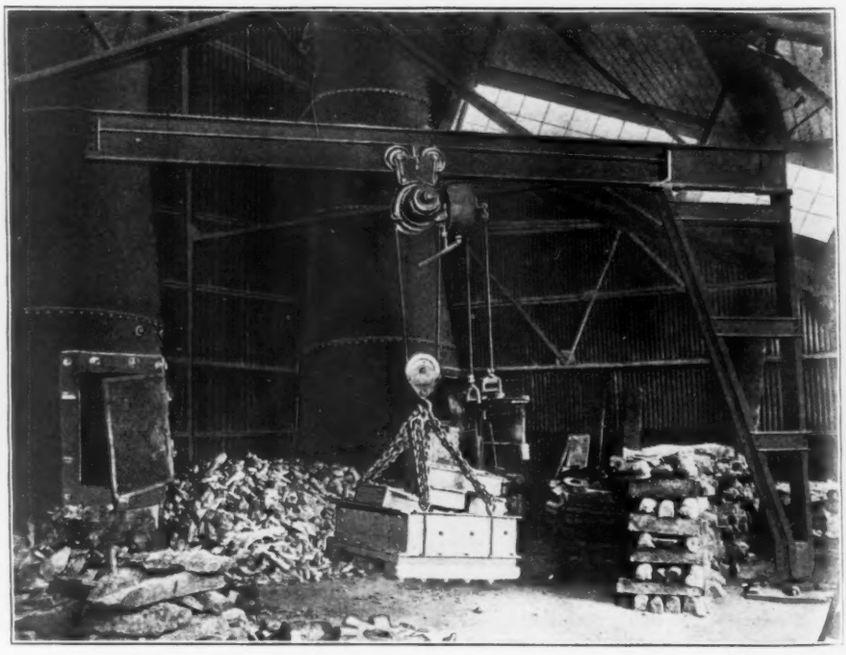
The accompanying illustration, from a photograph taken at the plant of the Colvin Foundry Co., Providence, R. I., is interesting as it shows a crane arrangement for the charging floor which has been found of great convenience. This foundry operates two cupolas, located side by side in the usual manner. Directly across from them, but at a sufficient distance from the opposite wall so as to allow it to complete about three-fourths of a circle, is mounted a one-ton Shepard front braced jib crane, made by the General Pneumatic Tool Co., Montour Falls, N. Y. This crane, with an effective radius of about sixteen feet, is located so as just to clear the cupolas. It is employed to throw all the heavier pieces of scrap directly into the cupola, but in addition handles all the bulkier materials going into the charge. A trap door is provided through the floor to permit the hoisting of the sprues, gates and other accumulations of scrap directly from the molding floor below. Coke, iron and other scrap are brought up to the door of the charging floor by an industrial car on which a rack is mounted. This rack is removable in order that the crane can dispose of these materials wherever is most convenient. The crane commands a large proportion of the area of the charging floor and the arrangement has been found satisfactory in every way.

GAS PRODUCER FOR SKIN DRYING MOLDS.

Many devices are now in use in foundries for skin drying molds, the ordinary coke basket still being employed to a large extent. The American Carburetor Mfg. Co., Mt. Vernon, O., has recently placed a gas producer on the market which is portable and by which gas can be produced at a low cost. It can be used not only for skin drying molds, but large cores as well, and as compared with charcoal or coke baskets the time required for drying is greatly reduced. In addition the heat can be forced into the smallest crevices of the mold and all parts will be left clean.

Tests have been made which show that 800 feet of gas have been produced from one gallon of gasoline and a higher temperature has been secured than that produced by either natural or artificial gas. The producer consists of a tank having suitable pipe connections. Air is used at a pressure of about 2½ pounds.

As shown in Figs. 1 and 2 the burner is made of ordinary gas pipe. In Fig. 2 the method of drying the mold is shown. The cope of the mold is



CHARGING FLOOR CRANE

placed over the drag, a space of about three inches being maintained between the two parts. In this way the drag and the cope can be dried at the same time, whereas with a charcoal or coke fire both parts are dried separately. The method of drying the core is shown in Fig. 1.

The producer can be furnished with tanks containing from 5 gallons of gasoline up to any capacity required, and the burners are made in all shapes to suit the various molds to be dried. The gas generated by this machine can also be used for lighting and heating purposes.

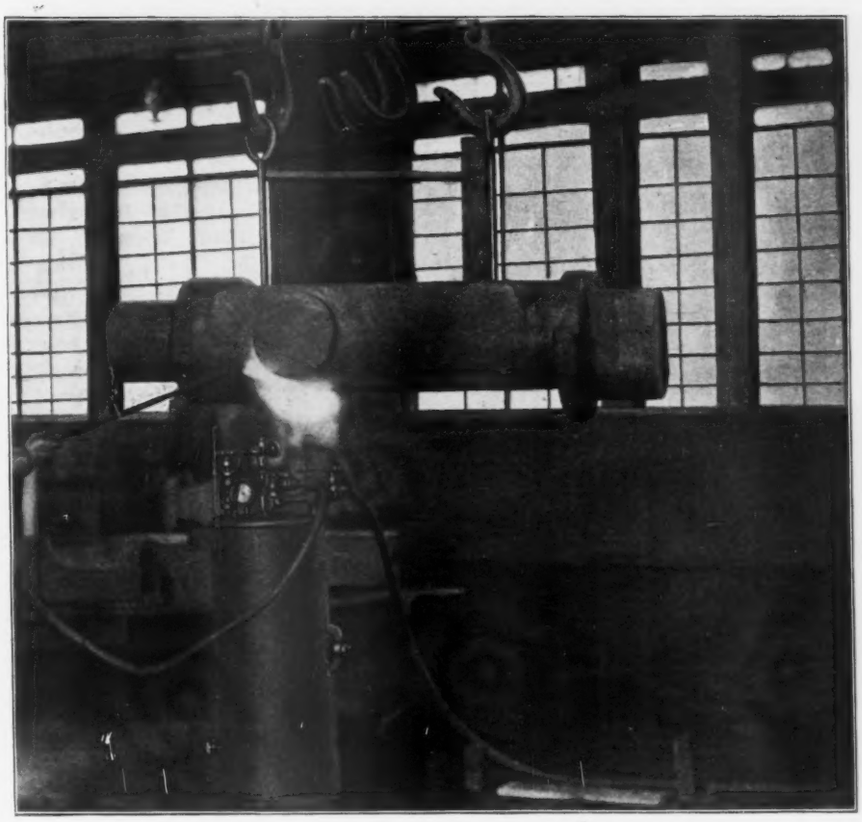


FIG. 1—DRYING A LARGE CORE

TRADE NOTES.

The Detroit Foundry Supply Co., Detroit, has adopted a unique circular for use by its traveling representatives to notify the trade of their periodical visits. It contains the likenesses not only of all of the officers of this concern, but of its representatives as well.

The Northern Engineering Works, Detroit, reports the following sales: Clyde Iron Works, Duluth, two 10-ton and one 15-ton electric traveling cranes; Erie Foundry Co., Erie, Pa., three-motor electric 10-ton traveling crane; Peninsular Motor Co., Grand Rapids, Mich., Newten cupola; Modern Iron Works, Quincy, Ill., Newten patent cupola; R. Hoe & Co., New York, three 10-ton electric traveling cranes and a Newten cupola.

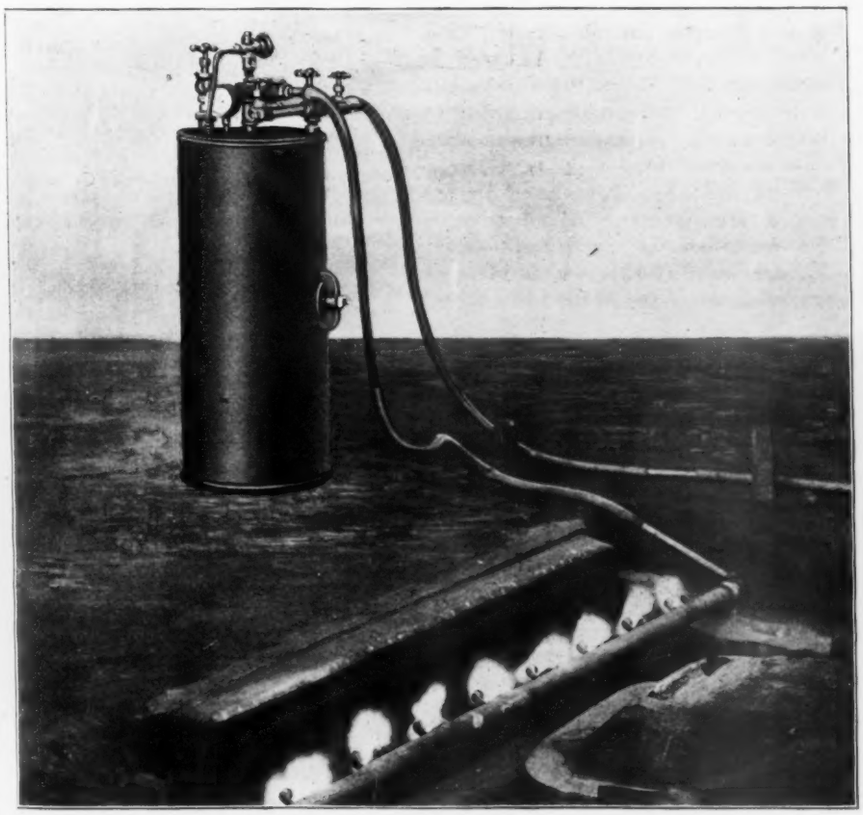
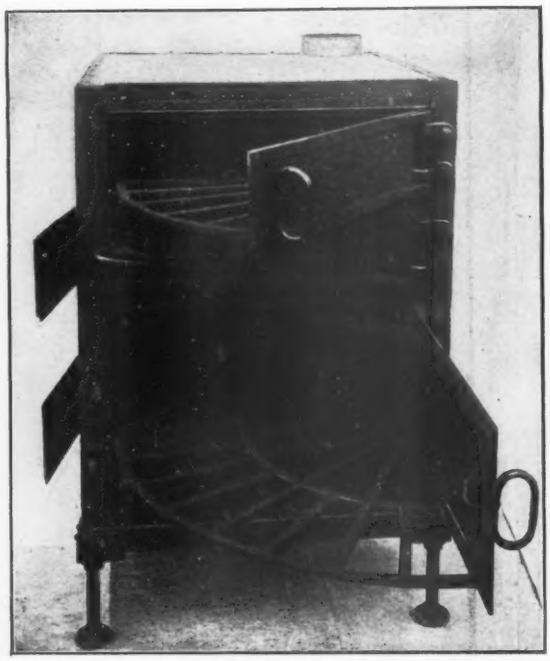


FIG. 2—SKIN DRYING A MOLD

The American Blower Co., Detroit, has recently installed heating and ventilating equipment in the following plants: Clarage Foundry & Mfg. Co., Kalamazoo, Mich.; Standard Pulley Co., Cincinnati; Ajax Iron Works, Corry, Pa.; Reading Iron Co., Reading, Pa.; T. H. Symington Co., Corning, N. Y.; special pressure blower for furnaces was furnished the Dominion Car & Foundry Co., and No. 9 pressure blowers with counter shaft and adjustable channel iron beds were furnished the Grand Trunk railway, Stratford, Ont., and the Toledo Ship Building Co., Toledo, O.

The S. Obermayer Co., Cincinnati, has recently issued a special number of the *Obermayer Bulletin*, which is devoted exclusively to core room equipment. It contains a number of well written articles on core work and in addition shows a large number of labor-saving appliances for use in the core room.

The very marked increase in the sale of "Glutrin" to the foundry trade, this especially during the last three months, has caused the Robeson Process Co. to make a change in its office locations. As shipments to the foundry trade are all made from its Au Sable Forks, N. Y., plant, its executive offices have been moved to that point. The New York offices at 39



OVEN FOR DRYING SMALL CORES

Cortlandt street, will be under the direct charge of D. S. Robeson. These changes involve the discontinuance of the Camden, N. J., office and warehouse. The stock carried there will hereafter be handled by Pettinos Brothers at Philadelphia and Bethlehem, Pa.

The Garden City Sand Co., Chicago, has been awarded the contract for furnishing all of the fire brick required in the erection of the annealing and malleable furnaces of the Hoopeston Malleable Iron Co., Hoopeston, Ill. Other contracts recently secured by this concern include the fire brick for two government garbage crematories at Newport, R. I., and Fort Russell, Wyo. Brick is also being furnished for the erection of the municipal garbage crematories in course of construction at Oak Park, Ill., and Hattiesburg, Miss.

The United States Graphite Co., Saginaw, Mich., miners of graphite and manufacturers of graphite paint, have recently issued a very interesting booklet entitled "About Graphite Paint." Graphite is now considered the only pigment that meets all of the many and varied requirements essential to the production of paint that will effectually protect under all conditions the surface which it covers. It is an inert substance, unaffected by extreme heat, frost, steam, water, sulphur fumes, acids, alkali, brine—or in fact by any climatic or chemical conditions. To give the best service, the graphite must be finely pulverized and thoroughly ground in the best linseed oil. The pigment should analyze not less than 85 per cent graphitic carbon, and the remaining 15 per cent should consist principally of such silica as is naturally carried by the ore from which it is ground.

The Wisconsin Engine Co., Corliss, Wis., has taken up the manufacture of gas engines for all services in sizes ranging from 400 to 5,000 horsepower. The engines are designed for the utilization of natural, producer, coke oven or blast furnace gas in the Otto cycle, and are of the horizontal tandem and twin tandem double acting types. This company controls the Sargent patents of internal combustion engines, and has employed Charles E. Sargent as the engineer of its gas engine department.

OVEN FOR DRYING SMALL CORES.

The S. Obermayer Co., Cincinnati, manufacturer of foundry supplies, has recently placed on the market an oven for drying small cores as shown herewith. While it is especially designed for use in smaller foundries, where it is not deemed advisable to install a large oven, it can also be used to advantage in shops equipped with large ovens and which occasionally have a number of small cores to bake. It is an exceedingly expensive operation to fire up a large oven to dry a few small cores, and in addition the operation is exceedingly slow. By the installation of a small oven the firing up of the large ovens would be obviated. The oven is portable, and is provided with three shelves, two 23½ inches deep and 4½ inches high and one 23½ inches deep and 9½ inches high. Its extreme height with legs, is 44 inches, and it is 29½ inches wide and 32⅞ inches deep.

TRADE PUBLICATIONS.

FOUNDRY BARRELS AND BOXES.—Cleveland Wire Spring Co., Cleveland. Catalog No. 27. 24 pages. Devoted to a description of steel shop boxes, barrels, kegs, pails, annealing pans, oily waste cans, factory stools, supply racks, factory shelving, and other specialties in shop equipment manufactured by this company. The boxes are made in varying sizes for almost all conceivable uses. Foundry barrels are manufactured both with and without trunnions. The trunnioned barrels can be moved about the shop on trucks. This concern also manufactures a full line of coiled wire springs and wire specialties of all descriptions.

SNAP BENCH.—J. M. Hudson, Piqua, O. Catalog devoted to a description of the portable molder's snap bench made by this concern, and described in the October issue of THE FOUNDRY. This bench is designed to replace the old style wooden type now largely used in most foundries.

LIFTING MAGNETS.—Cutler-Hammer Clutch Co., Milwaukee. Thirty-two-page booklet, which contains diagrams and complete information on the lifting capacity of magnets manufactured by this concern, as well as a number of full page illustrations showing lifting magnets handling pig iron, steel stampings, castings, scrap and other material. A new cable take-up device is also shown, and reference is made to the Cutler-Hammer system of control by which the strong inductive reaction which occurs when the circuit is suddenly opened on a magnet coil is automatically shunted to a discharge resistance, thus protecting the magnet by dissipating the energy of the induced voltage outside of the coil itself.

ELECTRIC TROLLEY HOISTS.—Northern Engineering Works, Detroit. Four-page pamphlet, devoted to a description of various types of hoists made by this concern. The hoists shown include a drum type with special hangers, two-motor electric traveling hoist, with hoist and travel motors, two-motor electric traveling hoist, with swiveled trucks and operator's cab and high and low types of electric trolleys.

CONTROLLERS.—Electric Controller & Supply Co., Cleveland. A novel booklet entitled, "You Can Reduce Operating Costs," has been issued by this company. It contains a history of the introduction of controllers and many pertinent and pithy statements are made regarding their utility in controlling the operation of electric motors. The matter contained in the booklet was originally read before the electrical engineers of the iron and steel industry at the Pittsburg meeting held Oct. 10, 1907.

ALUNDUM.—The Norton Co., Worcester, Mass. Twelve-page booklet devoted to a history of the invention and a description of the uses of this abrasive material.

INDUCTION MOTORS.—The Barrett Electric Mfg. Co., Cincinnati. Bulletin 106, 4 pages. The polyphase induction motors manufactured by this company are fully described. These motors are made in all sizes ranging from ½ to 50 horsepower for two or three phase circuits and are supplied for all standard voltages.

HOISTING AND HAULAGE ENGINES.—Litchfield Foundry & Machine Co., Litchfield, Ill. Thirty-two-page catalog. The hoisting, tail rope and stationary engines made by this concern are shown in detail, as well as differential haulage drums, patent cable grips, self-dumping cages and other mining equipment and supplies.

OUTERBRIDGE SILICON ALLOY.—Bulletin No. 16½, issued by the J. W. Paxson Co., Philadelphia, gives directions for the use of silicon alloy which is intended for softening and strengthening castings. It is used in the proportions of one pound to 400 or 500 pounds of iron, this quantity being dropped in the ladle before tapping. It is particularly suitable for iron containing less than 3 per cent silicon, and the scrap burden can be increased. It is also claimed that it reduces shrinkage and blow holes, and increases ductility. A large number of testimonials are published from foundries that have used this alloy successfully.

GENERAL INDUSTRIAL NOTES

The Eagle Foundry & Machine Co., Fort Scott, Kas., has been reorganized and Robert G. Long, formerly with the Missouri Pacific Railway Co.'s shops, has been made president and general superintendent.

The Detroit Stove Works, Detroit, has filed a certificate of increase of capital stock to $3,500,000, of which $2,000,000 is common and $1,500,000 is 6 per cent cumulative preferred.

The Topeka Foundry & Machine Co., Topeka, Kas., manufacturer of agricultural implements, has recently purchased several thousand dollars' worth of new equipment and has made its foundry one of the most modern in Kansas.

The Eagle Casting Co., Winchester, Ky., has been organized with a capital of $15,000, to manufacture gray iron and semi-steel castings. The main building, 60 x 120 feet, will be equipped with an electric traveling crane, automatic chipping machinery and sand blast cleaners. The company will furnish castings for the Hagan Gas Engine & Mfg. Co. during the coming year, and this contract alone will keep the plant reasonably busy.

The West Foundry Co., Sharpsville, Pa., has placed in operation the additions which it recently completed.

The Bonney-Floyd Co., Columbus, O., manufacturer of steel castings, is now successfully operating its new plant and producing castings of perfectly satisfactory quality. It will increase its output as rapidly as possible to keep pace with the growing demand for its product, as its outlook for future business is very good.

The Niagara Radiator & Boiler Co., Buffalo, has been incorporated with a capital of $200,000, and will manufacture radiators, furnaces, cast iron boilers, etc. The business and plant of the Niagara Radiator Co., North Tonawanda, N. Y., will be taken over by the new company. Edwin C. Andrews, John T. Andrews and Hiram C. Ballard are the directors, and Edward C. Andrews is president and manager.

The Union Machine & Foundry Co., Muskogee, I. T., has taken over the Reeves Machine Works of the same city and will spend $30,000 in increasing the capacity of the foundry recently added to the plant. U. S. King, of Iola, Kas., inventor of the King gasoline engine, is interested in the enterprise.

The Buchanan Foundry Co., Queens, N. Y., has been organized with a capital of $30,000 by G. L. Steubner, George Buchanan, and High Quinn. The company will manufacture iron and steel, steel forgings, etc.

The Model Pattern Co., Manhattan, New York, has been formed by W. F. Cook, G. M. Lamb, and G. H. Bladworth, to manufacture patterns, molds, models, etc. The capital stock is $100,000.

The Weber Foundry Co., Cincinnati, is alleged bankrupt by petition of creditors. The statement of condition, dated Oct. 31, 1907, showed assets of $54,397.65, with indebtedness of $43,744.70. Messrs. Domhoff, Lodge and the Brighton German bank were named a committee to take charge of the plant, which will be closed down until a suitable purchaser can be found. The Weber foundry made all the castings for the Lodge & Shipley Machine Tool Co., thus having one of the most valuable contracts in the locality.

The Hempfield Foundry Co., Greensburg, Pa., has filed articles of incorporation with a capital of $45,000. The directors are: Harry G. Burkett, J. H. Eisman, J. Howard Patton, L. B. Huff and Richard Coulter Jr., all of Greensburg.

The National Foundry Co., Tacoma, Wash., has been incorporated with a capital of $25,000, to conduct a jobbing gray iron foundry business. The company has begun operating its new iron foundry and expects later to add a brass department and malleable plant.

The F. Holtz Co., Evansville, Ind., has been incorporated with a capital of $35,000, and will operate a general foundry and machine shop. The directors are: Ferdinand Holtz, Ferdinand Holtz Jr. and Henry Holtz.

The Myrick Machine Co., Olean, N. Y., has been incorporated, with a capital stock of $50,000, to manufacture engines and boilers and conduct a foundry business. The incorporators are: Alfred and Edward M. Tothill and Peter J. Messer, all of Olean, N. Y.

The Reliance Steel Foundry Co. has purchased the steel casting plant of the Cooper-Wigand-Cooke Co., Delawanna, N. J., and is equipping it to produce miscellaneous machinery, locomotive and marine castings, ranging from 25 pounds to 20 tons, by the acid open-hearth process. The plant will have a capacity of 1,000 tons of castings monthly and will be in operation early in October. S. A. Watson is president; W. F. Watson, formerly connected with the American Steel Foundries, vice president, and Arthur Falkenau, treasurer.

The Samson Iron Works, Stockton, Cal., is erecting a foundry 100 x 125 feet, of brick and steel construction, which it expects to have in operation early in the fall. The company recently added a new machine shop and will spend $25,000 on the construction and equipment of the foundry, which will supply castings for its line of gas engines and centrifugal pumps.

The Portland Foundry & Machine Co., Portland, Ind., has been incorporated with a capital stock of $25,000, to take over the business of the Sixbey & Grumme Co., of the same city. The new company will do all kinds of foundry, machine and boiler work. The officers are: J. A. Long, president; William A. Fields, vice president; Frederick Grumme, secretary; L. G. Holmes, treasurer.

The Advance Radiator Co., Syracuse, Ind., has been organized with a capital of $60,000, and is erecting a plant, of cement and steel construction, for the manufacture of radiators and boilers, and will also do a general machine shop and foundry business. The company has acquired the plant of the Reynolds Heater Co., Warsaw, Ind., and will move its equipment to Syracuse as soon as the new plant is completed. The officers of the new company are: President, Timothy Holland; secretary, Charles B. Bentley; treasurer, Silas L. Ketring; superintendent, Carey Wright. Other directors are Lewis A. Neff, Elmer E. Strieby and B. I. Holland.

The Bay View Foundry Co., Sandusky, O., will erect a foundry building 80 x 100 feet.

The Industrial Works, Bay City, Mich., manufacturer of wrecking, locomotive and station cranes, is preparing plans for a new gray iron and steel foundry, 160 x 300 feet. This will materially increase the capacity of the plant, which is now taxed as a result of largely increased business.

The General Foundry & Machine Co., Syracuse, N. Y., has been incorporated to manufacture iron, steel, etc., with a capital of $150,000. The incorporators are: L. A. Saxer, M. E. Driscoll and G. F. E. Meistering, of Syracuse.

The Dixon Mfg. Co., Dixon, Ill., has been incorporated with a capital of $10,000, to operate a foundry and machine shop. The incorporators are: David E. Spencer, Henry U. Berdwell, and Abalino C. Berdwell.

The Philippi Foundry & Machine Co., Philippi, W. Va., has been organized by E. R. Dyer, S. A. Moore, J. C. Watson, A. G. Dayton, and C. F. Teter, with a capital of $20,000. The company will manufacture car wheels and engage in a general foundry business.

New Construction.

The J. A. Oberhelman Foundry Co., Cincinnati, is planning to install electric power in its foundry and make other improvements which will increase its capacity. An addition to the present plant is contemplated.

The John J. Bruce Foundry Co., Cincinnati, is preparing plans for an office and pattern building which will be two stories, 50 x 100 feet. A new foundry building is now under construction.

The United States Radiator & Boiler Co., West Newton, Pa., is erecting a fireproof foundry building, 299 x 326 feet, to replace its foundry recently destroyed by fire. It is expected that this building will be completed by Jan. 1, and the most modern foundry equipment will then be installed.

The Samson Iron Works, Stockton, Cal., is building a new foundry, 100 x 175 feet, of brick and steel, which it expects to have in operation by Jan. 1. Modern equipment, including two Colliau cupolas and a Pawling & Harnischfeger 10-ton electric crane, will be installed. A brass foundry will also be added. The foundry will furnish castings for the gas and oil engines and pumps manufactured by this company.

The Harrold Foundry & Machine Co., New Kensington, Pa., manufacturer of punches, shears and castings, is adding to its foundry a building 45 x 80 feet. Another cupola will be installed, which will increase its melting capacity to 25 tons per day.

The Peerless Mfg. Co., Inc., Louisville, Ky., has erected a new foundry building to replace the one recently destroyed by fire.

The Bay View Foundry Co., and the Sandusky Foundry & Machine Co., Sandusky, O., have purchased the plant and grounds of the Standard Wheel Co. of that city. The Bay View Co., which has leased the foundry department of the Sandusky Foundry & Machine Co. for the past three years, has prepared plans for a foundry to be erected on its portion of the land. The building will be 80 x 150 feet, of steel frame with brick walls and composition roof. Modern foundry equipment will be required.

The C. B. Cottrell & Sons Co., Westerly, R. I., printing press manufacturer, will erect a two-story and basement machine and erecting shop, 110 x 150 feet, of brick mill construction, at an estimated cost of $50,000.

Charles H. Birmingham, 231 South Exeter street, Baltimore, brass foundryman, recently purchased a site for a new plant. Plans for its erection are not yet completed, but he states that the plant will be operated by turbine and electrical power.

The Bucyrus Iron Works, Bucyrus, O., has been organized with a capital of $50,000, and has purchased the foundry of the Shunk Foundry Co. of that city. This plant occupies a site of five acres and consists of a brick foundry building, 60 x 200 feet, with two 5-ton cranes; engine building, 30 x 40 feet; core room building, 30 x 30 feet; pattern shop and pattern storage, 40 x 70 feet. Plans for further extensions have not yet been completed, but the company expects to add a modern machine shop during the coming year.

The Reading Stove Works, Reading, Pa., is erecting a five-story warehouse and three large foundry buildings. The warehouse will be fireproof, of brick, 50 x 60 feet. Each of the foundry buildings will be one story high, of brick, 40 x 120 feet.

The New Process Steel Co., Marshall, Mich., which was organized less than a year ago, is now enlarging its plant to meet the demand for its high grade crucible steel castings for automobiles, gas engines and machinery. The addition, 50 x 123 feet, will be used for cleaning and shipping rooms, core room, pattern storage, etc., giving the entire floor space of the present building, 60 x 123 feet, for foundry purposes. S. F. Dobbins is president; F. A. Stuart, vice president; F. S. Deuel, treasurer, and S. C. French, secretary and manager.

The Marion Machine, Foundry & Supply Co., Marion, Ind., has completed its new brick building, 66 x 132 feet, which will be used for foundry work, leaving the remainder of the plant for the machine department. The working force will be increased from thirty to sixty-five men.

The Johnston Harvester Co., Batavia, N. Y., has purchased land adjoining its plant and will erect a large malleable iron foundry. About 150 men will be employed and the company will conduct a jobbing business in addition to supplying its own requirements.

The Hoopeston Malleable Iron Works, Hoopeston, Ill., recently organized, is erecting a plant for the manufacture of malleable iron castings. This will include a main building, 110 x 250 feet, a second structure, 80 x 150 feet, and several smaller buildings. Air furnaces, annealing ovens, etc., will be required. The officers of the company are: S. D. Porter, president; Minnie Porter, vice president, and J. A. Scanland, secretary and treasurer.

The Terre Haute Malleable & Mfg. Co., Terre Haute, Ind., manufacturer of malleable iron castings and hardware specialties, will begin work at an early date on its new foundry. The building will be 82 x 270 feet and will include a 12-ton melting furnace.

The City Foundry Co., Cleveland, will erect an addition to its foundry, at a cost of $12,000.

A new pattern shop for steam engineering will be constructed at the United States navy yard, Portsmouth, N. H. The building used for this purpose was recently destroyed by fire, and the new building, which was already planned, will opportunely replace a portion of the damaged plant.

The Lisle Mfg. Co., Clarinda, Ia., will erect a new foundry building, 54 x 100 feet, which will be of concrete construction, with saw tooth roof.

The Iron City Sanitary Mfg. Co., Zelienople, Pa., has had plans prepared for a new foundry building, 60 x 240 feet. The building will be of steel and concrete construction and will be equipped with 16 Herman pneumatic molding machines designed for molding large bath tubs and other sanitary ware. This new foundry is expected to have a capacity for handling 2,000 castings per day. The molding and pouring will be continuous and a conveyor will be installed to handle automatically the molds and sand.

The Elmwood Castings Co., Station P, Cincinnati, has purchased a site of six acres on the Murray road and Big Four railroad, and will erect a plant for the manufacture of gray iron castings. A foundry building, of brick and steel construction, 125 x 300 feet, divided into two bays of 35 feet each and a central bay of 50 feet, will be erected, with provision made for an addition of equal size. A full line of modern foundry machinery will be installed. James E. Stacey is president; S. W. Spear, vice president and general manager; A. L. Hope, treasurer; Joseph Rawson Jr., secretary.

The Prime Steel Co., Milwaukee, which suffered a serious fire in its foundry May 7, is replacing the burned structure with a building 80 x 140 feet. This is of solid brick saw tooth construction, and modern in every respect. The power plant, cleaning room, core room and pattern storage will also be of solid brick, and the pattern storage will be strictly fireproof. All equipment has been ordered.

The New Departure Mfg. Co., Bristol, Conn., will erect at its bell department in East Bristol, a brass foundry 40 x 40 feet, of brick construction.

Improvements are now under way at the Espe foundry, Crookston, Minn., which will increase its dimensions to 75 x 140 feet, and another story is also being added.

The Eagle Foundry Co., Fort Scott, Kas., will replace its plant recently destroyed by fire with a much larger structure. It will spend $60,000 on the new building, which is to be 60 x 200 feet, and expects to have it in operation within sixty days.

The Peerless Machinery & Supply Co., Wichita, Kas., is erecting a stone structure 50 x 75 feet, adjoining its main factory building, which will be used for foundry purposes.

The Samuel C. Tatum Co., Cincinnati, will erect a new foundry plant. The main building will be five stories high, 60 x 266 feet, and the foundry building one story high, 110 x 300 feet, of steel construction.

The Gardner General Foundry Co., Gardner, Mass., incorporated recently to take over the two foundries formerly owned by the Gardner Foundry Co. and the General Foundry Co., has sold its interest in the former to Gustaf E. Hoglund, who has been superintendent of the consolidated foundries and one of the directors of the corporation. Mr. Hoglund will conduct his business under the name of the G. E. Hoglund Foundry Co. The Gardner General Foundry Co. is now owned and operated by Edward G. Watkins and Ralph N. Wiley, to whom Mr. Hoglund has sold his interest.

J. H. Newbury, Goshen, N. Y., is building addition to his foundry plant, which was recently seriously damaged by fire. The new building is 23 x 115 feet, and repairs are being made to other portions of the plant not completely destroyed.

The United Engineering & Foundry Co., Youngstown, O., is preparing plans for an addition, three stories, 85 x 200 feet, of brick and steel construction.

The Cleveland Foundry Co., Cleveland, is adding two stories to its addition recently completed, which will make the finished structure four stories, 50 x 175 feet.

The new plant which the Charlotte Pipe & Foundry Co., Charlotte, N. C., manufacturer of cast iron soil pipe and fittings and plumbers' supplies, is building, will more than double its present capacity. The main foundry building covers over two acres of ground, and the other buildings comprise extensive machine and pattern shops and storage warehouses. Electricity will be used for motive power, and several miles of industrial tracks will facilitate the handling of material. It is expected that the new plant will be in operation within the next 30 days.

The New Holland Machine Co., New Holland, Pa., is erecting a new foundry, 85 x 100 feet, which will enable this company to increase its output from 60 to 75 per cent.

Brass Foundries.

The Canton Brass Co., Canton, O., which began the manufacture of brass specialties and castings a few months ago, has already completed extensions which will give it three times its former capacity. A brick foundry building, 50 x 160 feet, coke and metal building, 40 x 60 feet, and pattern storage, 18 x 26 feet, have been erected and an extension to the machine shop is contemplated.

The Turner Brass Works, Sycamore, Ill., has increased its capital stock from $150,000 to $168,000.

A new brass foundry is to be built at Niagara Falls, Ont., to take the place of one recently destroyed by fire in that city. The new concern, which is backed by Montreal men, will take the name of the Niagara Falls Brass Manufacturing Co. A site, 150 x 188 feet, has been secured and work upon the buildings will be begun immediately.

The Menselring Brass Foundry Co., Milwaukee, has been incorporated with a capital of $6,000, and will manufacture small brass castings. The incorporators are: Edwin Menselring, Lizzie Menselring, Barbara Schmid and John Thinnes.

The Arequipe Machine & Foundry Co., New York, has been formed with a capital of $15,000 by Thomas Wright and John B. Curry, of New York, and Josiah M. Johnston, of Jersey City. The company will manufacture brass and iron castings.

The Queensborough Brass & Bronze Foundry has moved into its new building, 184 Broadway, Astoria, N. Y., where increased facilities will enable the company to double its output.

The Appleton Brass Co., Boston, has been incorporated with a capital of $3,000, by William Bunting Jr., R. V. Bunting, and Frank H. Locke.

The Norwich Nickel & Brass Co., Norwich, Conn., has increased its capital stock from $80,000 to $125,000. The increase in capital will be used for the enlargement of its plant and the extension of its business.

The Caldwell & Ward Brass Co., Syracuse, N. Y., manufacturer of brass castings, has recently been incorporated as successor to the Central City Brass Mfg. Co.

The Walnut Machine & Brass Foundry Co., Toledo, has been incorporated with a capital of $10,000, by E. L. Rowe, E. G. Schuler, E. J. Vollmer, Amos McDonald and Walter A. Antler.

Interior Foundry View, Merrimac Iron Foundry, Lawrence, Mass.

This modern foundry equipped with two *Whiting* Electric Traveling Cranes, *Whiting* Cupolas, Ladles, Tumblers, Trucks, Turntables, etc.

CRANES AND CRANES

We make them of every description and for every class of service.

Illinois Steel Co. using 100 Whiting Cranes

These were not all purchased at the same time. They constitute numerous REPEAT ORDERS and clearly prove the WORTH of

WHITING CRANES

Not the least important ingredient of Whiting Cranes is our *experience*, which is practical and extends over a period of thirty years.

MAY WE HAVE THAT INQUIRY?

Get our complete Crane Catalog No. 45—The Recognized Crane Text Book.

ENGINEERS DESIGNERS MANUFACTURERS

WHITING FOUNDRY EQUIPMENT CO.

HARVEY, ILL. (Chicago Suburb.)

See our advertisement on Page 56.

ADVERTISERS

Adams Co. 20, 141
Addy, Matthew, & Co. 159
Ajax Metal Co. 153
American Air Compressor Works. 124
American Blower Co. 48
American Wire Brush Co. 118
Arcade Mfg. Co. 22
Atlas Car & Mfg. Co. 135

Baird & West 159
Batcheller, Clark & Batcheller. 125
Barnett, Oscar, Foundry Co. 26
Bartlett, N. S., & Co. 159
Basic Chemical Co. 150
Bassite Mining & Smelting Co. 46
Batavia Clamp Co. 143
Berkshire Mfg. Co. 25
Blackwell, Geo. G., Sons & Co. 152
*Blake, Geo. F., Mfg. Co. —
Bonvillain, Ph., & E. Ronceray. 16
Borgner, Cyrus, Co. 157
Box & Co., Alfred. 129
Brass Founders' Supply Co. 144
Bridgeport Safety Emery Wheel Co. 124
Bristol Co. 152
Brown Hoisting Machinery Co. 131
Brown Specialty Machinery Co. 34
Burdick & Son 144
*Byram & Co. —

Carborundum Co. 123
Carr & Speer 154
Case Mfg. Co. 130
Central Foundry Supply Co. 138
Chicago Pneumatic Tool Co. 28
Clark Cast Steel Cement Co. 44
Cleveland Crane & Car Co. 129
Cleveland Fillet Co. 155
*Columbus Iron & Steel Co. 158
Connersville Blower Co. Back cover
Cornell, J. B. & J. M., Co. 157
Crivel & Co., George F. 135
Curtis & Co. Mfg. Co. 39

*Deane Steam Pump Co. 140
Debevoise-Anderson Co. 159
DeCamp Bros. & Yule Iron, Coal & Coke Co. 159
Detroit Foundry Supply Co. 121
Diamond Clamp & Flask Co. 144
Dimmick, J. K., & Co. 159
Dings Electro Magnetic Separator Co. 146
Dixon, Jos., Crucible Co. 51
Dobson, William 148
Dodge & Day 154
Doggett, Stanley 143
Domhoff & Joyce Co. 158
Drucklieb, C. 123

Electric Controller & Supply Co. 133
Elm City Engineering Co. 146
Engineers' & Founders' Laboratories. 155
Etting, Edward J. 137

Falls Rivet & Machine Co. 10
Field, Alfred, & Co. 149
Field, Robt., Sales Agency 158
Fisher, Alfred 139
Foundry Specialty Co. 142
Fox Machine Co. 155

Gautier, J. H., & Co. 54, 157
General Pneumatic Tool Co. 131
Gilmour, J. 138
Goldschmidt Thermit Co. 142
Goodrich, F. A., & Co. 159

Hanna Engineering Works 35
Harbison-Walker Refractories Co. 157
Harrington, Edward, Sons & Co. 132
Hawley Down Draft Furnace Co. 36
Herman Pneumatic Machine Co. 19
Hill Brothers 143
Hill & Griffith Co. 6
Hillman, J. H., & Son. 158
Hoist Co., The. 130
Holland Linseed Oil Co. 149
Hooper, G. K. 154
Hudson, J. M. 145

Independent Pneumatic Tool Co. 125

Jones & Attwood 149

Keep, W. J. 154
Kerr Turbine Co. 147
Kessler & Weidemann 154
Killing Molding Machine Co. 21

Laclede-Christy Clay Products Co. 157
Lindsay, W. W., & Co. 27
Link-Belt Co. 133
*Loughry, James C. 125

MacKellar's Sons Co. 150
Manning, Maxwell & Moore. 128
Maris Bros. 130
Maurer, Henry, & Son. 157
McCormick, J. S., Co. 24
McCullough-Dalzell Crucible Co. 52
McKeefrey & Co. 158
Metallic Alloys Co. 152
Metallurgical Laboratory 152
Middleditch, Benj. 145
Midvale Mining & Mfg. Co. 151
Millett Core Oven Co. 33
Mitchell-Parks Mfg. Co. 23
Mohr, J. J., & Son. 158
Monarch Emery & Corundum Wheel Co. 124
Monarch Engineering & Mfg. Co. 37
Morton Manufacturing Co. 30
Moyer Tramrail Co. 134
Mumford, E. H., & Co. 17, 18

Nash, Isham & Co. 159
New England Eng. & Equipment Co. 135
New Era Mfg. Co. 152
Newport Sand Bank Co. 132
Niles-Bement-Pond Co. 132
Northern Engineering Works. 128, 136
Norton Co. 42
Norwalk Iron Works Co. 147

Obermayer, S., Co. ....Inside front cover 1
Osborn Mfg. Co. 153
Otis Steel Co. 138

Paige Retort & Crucible Co. 137
Pangborn, T. W., Co. 7
Partamol Co. 140
Pattern Letter Co. 155
Pawling & Harnischfeger. 129
Paxson, J. W., Co. 2, 3, 4
Peninsular Tool & Specialty Co. 148
Penn, Wm., Silica Works. 157
*Pettinos Bros. —
Phosphor Bronze Smelting Co. 153
Pickands, Brown & Co. 159
Pickands, Mather & Co. 158
Filling & Crane 158
Piqua Blower Co. 55
Pridmore, Henry E. 12, 13

Rathbone, John A. 18
Rendle, Arthur E. 150
Ridgway, Craig, & Son Co. 40
Roberts Portable Oven Co. 148
Robeson Process Co. 32
Rockwell Engineering Co. 137
Roessler & Hasslacher Chemical Co. 151, 153
Rogers, Brown & Co. 159, 160
Roots, P. H. & F. M., Co. ....Insert
Ross-Tacony Crucible Co. 53

Samuel, Frank 158
Seaver, John W. 154
Seidel, R. B., Inc. 137
Sellers, Wm., & Co. 29
Shanafelt Mfg. Co. 31
Shelton Metallic Filler Co. 43
Shepard, Chas. G. 159
Shuster, F. B., Co. 146
Sly, W. W., Mfg. Co. 11
Smith, J. D., Foundry Supply Co. 8
Smooth-On Mfg. Co. 45
Smyth, Swoboda & Co. 143
Standard Sand & Machine Co. 141
Sterling Oil Co. 149
Stevens, F. B. 9, 119, 159
Stow Mfg. Co. 123
Stradley & Co., Edward M. 148
Sturtevant, B. F., Co. 49
Superior Charcoal Iron Co. 127

Tabor Mfg. Co. 14, 15
Taylor, A. L. 155
Taylor, Robt. J., Inc. 50
Thomas Furnace Co. 159
Tilghman-Brooksbank Sand Blast Co. 41
Turner Machine Co. 141

U. S. Chaplet Supply Co. 141
United Iron & Steel Co. 38
United States Graphite Co. 150

Waldie & McCauley Sand Co., The. 147
Walter-Wallingford & Co. 158
Western Foundry Supply Co. 151
Whitehead Bros. Co. 5
Whiting Foundry Equipment Co. 56, 117
Wilbraham-Green Blower Co. 47
Wonham & Magor 136

Yale & Towne Mfg. Co. 133

MINERVA

SIMPLE ALGEBRA

1. EFFICIENCY = Best average result throughout life.
2. EFFORT = Perspiration x Cusswords.

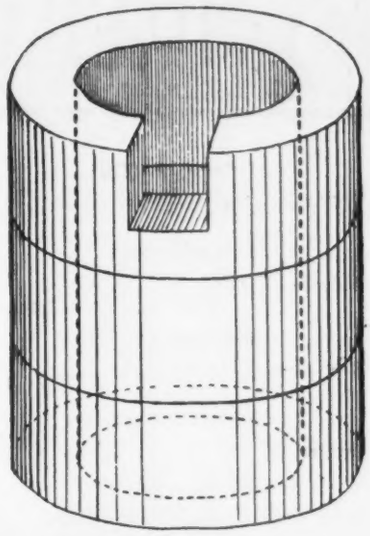
Hence - - $\frac{\text{Efficiency x Life}}{\text{Cost x Effort}}$ = DOLLAR & CENT VALUE.

That's the reason why the foxy foundries buy the flexible **Minerva.** It gives double result at half effort and retains the elastic step of youth.

Write to **AMERICAN WIRE BRUSH CO., New York.**

TEST THE CHEAPEST BRUSH

Brass Founders' Supplies



BRASS FURNACE BLOCKS

The toughest, most refractory, most durable and most economical block on the market; outwears every other lining. Made to fit any brass pit, and all sizes in stock.

Made of same material as Stevens' Cupola Blocks, which fit any cupola, and give long life, thereby reducing your cost.

If you operate a Polishing and Plating Department,

Look Here!

One of the expenses of the plating room is the cost of Spanish Felt Wheels. You may renew the life of these wheels after they have become hard from long service with the use of STEVENS' POLISHERS' FRIEND.

It is put up in paste form in paper cartons. It costs less than tallow, besides this composition has cutting qualities as well as producing the softening effect upon the wheel.

Notice the name "Stevens" on each package.

White Columbia Coloring

Prepared and shipped in cakes that just fit the hand. Its use gives a fine finish to nickel plated work and fine brass castings where a higher color is required. It is especially invaluable for use on castings having embossed parts or deep backgrounds. The particles left in the interstices are easily washed out. It is sometimes called "White Rouge." It is put up in brick form and offered at a low figure.

If you want to save money get my prices and samples for test before placing your orders. These compositions are known all over the country. They are goods of QUALITY.

I make Foundry Facing and Supplies, Polishers' and Platers' Compositions, Spanish Felt Wheels, Fire Brick, Flat Fire Tile, Cupola Blocks, etc., etc.

My men sell anything you want for a successful foundry. They go up against those who sell only one thing.

It takes a smaller slice of profit to sell you all the goods; I take the small slice, you take the rest. Here's where you win. That's the way you profit when you deal with STEVENS.

FREDERIC B. STEVENS

DETROIT, MICH.

FACING MILLS
Isabella Ave. and M. C. R. R.

OFFICES
Corner Larned and Third Sts.

See Page 9.

BUYERS DIRECTORY

Advertisements can be found readily by reference to the Alphabetical Index

Abrasive Materials:
Carborundum Company, Niagara Falls.
Norton Company, Worcester, Mass.

Accountants:
Stradley & Co., Edward M., Philadelphia.

Air Compressors:
American Air Compressor Works, New York.
Chicago Pneumatic Tool Co., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Independent Pneumatic Tool Co., Chicago and New York.
Norwalk Iron Works Co., So. Norwalk, Conn.

Alloys:
Blackwell, Geo., Sons & Co., Ltd., Liverpool, Eng.
New Era Mfg. Co., Kalamazoo, Mich.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Analysis—Mechanical:
Keep, W. J., Detroit.

Analysis—Chemical:
Engineers & Founders Laboratories, Pittsburg.
Kessler & Wiedemann, St. Louis, Mo.
Metallurgical Laboratory, Pittsburg.

Anchors:
Lindsay, W. W. & Co., Philadelphia.

Babbitt Metal:
Ajax Metal Co., Birmingham, Ala.

Bellows:
Osborn Mfg. Co., Cleveland.

Blowers:
American Blower Co., Detroit.
Connersville Blower Co., Connersville, Ind.
Cornell, J. B. & J. M. Co., New York.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson, J. W. Co., Philadelphia.
Piqua Blower Co., Piqua, Ohio.
Roots, P. H. & F. M. Company, Connersville, Ind.
Sturtevant, B. F., Co., HydePark, Mass.

Blowers—Positive Pressure:
Connersville Blower Co., Connersville, Ind.
Piqua Blower Co., Piqua, Ohio.
Roots, P. H. & F. M. Company, Connersville, Ind.
Sturtevant, B. F., Co., HydePark, Mass.
Wilbraham-Green Blower Co., Philadelphia.

Brakes (Electric):
Electric Controller & Supply Co., Cleveland.

Brushes:
American Wire Brush Co., New York.
Osborn Mfg. Co., Cleveland.

Buildings (Struct. Steel):
Lindsay, W. W. & Co., Philadelphia.

Burners (Oil):
Monarch Engineering & Mfg. Co., Baltimore.

Carbonese:
Midvale Mining & Mfg. Co., E. St. Louis, Ill.

Castings (Steel):
Otis Steel Co., Ltd., Cleveland.

Cement (Furnace):
Gautier, J. H. & Co., Jersey City.

Cement (Metallic):
Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.

Chaplets:
Burdick & Son, Albany, N. Y.
Lindsay, W. W. & Co., Philadelphia.
Shanafelt Mfg. Co., Canton, O.

Clamps:
Batavia Clamp Co., Batavia, N. Y.

Coke:
Dimmick, J. K., & Co., Philadelphia.
Debevoise-Anderson Co., New York.
Hillman, J. H. & Son, Pittsburg.
Rogers, Brown & Co., Cincinnati.

Conveyors:
Link-Belt Co., Philadelphia, Pa.

Cores:
Brown Specialty Machry. Co., Chicago.

Core Binders:
Holland Linseed Oil Co., Chicago.
Robeson Process Co., Camden, N. J.
Sterling Oil Co., Emlenton, Pa.

Core Machines:
Brown Specialty Machry. Co., Chicago.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Jones & Atwood, Stourbridge, Eng.

Core Ovens:
Atlas Car & Mfg. Co., Cleveland.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Hill & Griffith Co., Cincinnati.
Millett Core Oven Co., Brightwood, Mass.
Pangborn, Thos. W. Co., New York.
Paxson, J. W. Co., Philadelphia.
Roberts Portable Oven Co, Chicago.
Smith, J D., Foundry Supply Co., Cleveland.

Core Oven Recording Thermometer:
Bristol Co., Waterbury.

Core Tapering Machines:
Brown Specialty Machry. Co., Chicago.

Corundum Wheels:
Monarch Emery & Corundum Wheel Co., Camden, N. J.

Cost Keeping Systems:
Loughry, James C., Elyria, O.
Stradley & Co., Edward M., Philadelphia, Pa.

Cranes:
Brown Hoisting Machine Co., The, Cleveland.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Curtis & Co. Mfg. Co., St. Louis, Ill.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, New York.
Maris Bros., Philadelphia.
Niles-Bement-Pond Co., New York.
Northern Engrng. Works, Detroit.
Ridgway, Craig & Son, Coatesville, Pa.
Sellers, William & Co., Inc., Philadelphia.
Whiting Foundry & Equipment Co., Harvey, Ill.

Crucibles:
Dixon Crucible Co., Jos., Jersey City.
Gautier, J. H. & Co., Jersey City.
McCullough-Dalzell Crucible Co., Pittsburg.
Monarch Engineering & Mfg. Co., Baltimore.
Paige Retort & Crucible Co., Taunton, Mass.
Paxson, J. W. Co., Philadelphia.
Ross-Tacony Crucible Co., Philadelphia.
Seidel, R. B., Inc., Philadelphia, Pa.
Taylor, A. L., San Francisco.
Taylor, Robt. J., Inc., Philadelphia.

Cupolas:
Byram & Co., Detroit.
Detroit Foundry Supply Co., Detroit.
Etting, Edward J., Philadelphia.
Gilmour, J., New York.
McCormick, J. S. Co., Pittsburg.
Paxson, J. W. Co., Philadelphia.
Whiting Foundry Equipment Co., Harvey, Ill.
Wonham & Magor, New York.

Electric Generating Sets:
Sturtevant, B. F. Co., Hyde Park, Mass.

Elevators:
Curtis & Co. Mfg. Co., St. Louis.
Ridgway, Craig, & Son, Coatesville, Pa.

Engines (Steam):
American Blower Co., Detroit.

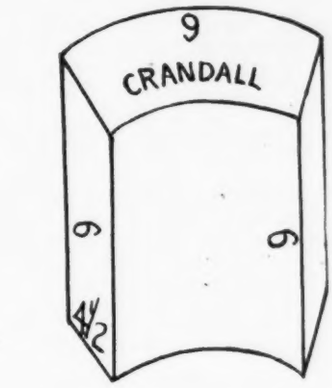
Engineers (Foundry, Mech., Elec., Etc.):
Carr & Speer, New York City.
Dodge & Day, Philadelphia.
Hooper, Geo. K., New York City.
Lindsay, W. W. & Co., Philadelphia.
Seaver, John W., Cleveland.

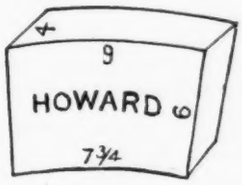
Exhausters (Gas):
Wilbraham-Green Blower Co., Philadelphia.

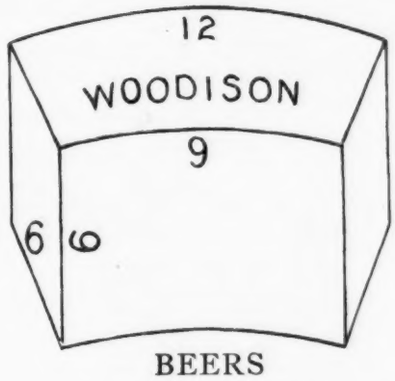
Economy

The Watchword of the Foundryman

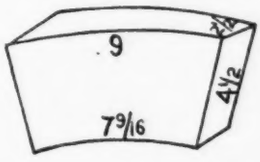
SOME buyers consider prices only, consider a cupola block as a cupola block, not the material in it. It may be cheap, both as to cost and contents. It costs just as much to reline your cupola with a poor, as a good quality, with the advantage of the good one lasting probably two or three times as long. Give a little thought to the cost of the completed structure and buy a block or brick guaranteed to do your work.







BEERS



We make four styles, any diameter—those shown here are standard sizes, in stock at works, Detroit and Windsor.

CRANDALL

No. 1—	16"	inside	diameter,	25"	outside diameter.
No. 2—	21"	,,	,,	30"	,, ,,
No. 3—	27"	,,	,,	36"	,, ,,
No. 4—	30"	,,	,,	39"	,, ,,
No. 5—	40"	,,	,,	49"	,, ,,
No. 6—	51"	,,	,,	60"	,, ,,
No. 7—	60"	,,	,,	69"	,, ,,
No. 8—	75"	,,	,,	84"	,, ,,

HOWARD

No. 1—	30"	inside	diameter,	42"	outside diameter.
No. 2—	36"	,,	,,	48"	,, ,,
No. 3—	48"	,,	,,	60"	,, ,,
No. 4—	60"	,,	,,	72"	,, ,,
No. 5—	72"	,,	,,	84"	,, ,,

WOODISON

No. 1—	30"	inside	diameter,	42"	outside diameter.
No. 2—	36"	,,	,,	48"	,, ,,
No. 3—	42"	,,	,,	54"	,, ,,
No. 4—	48"	,,	,,	60"	,, ,,
No. 5—	54"	,,	,,	66"	,, ,,
No. 6—	76"	,,	,,	88"	,, ,,

BEERS

No. 8—	24"	inside	diameter,	33"	outside diameter.
No. 9—	30"	,,	,,	39"	,, ,,
No. 10—	36"	,,	,,	45"	,, ,,
No. 11—	48"	,,	,,	57"	,, ,,
No. 12—	60"	,,	,,	69"	,, ,,

The Detroit Foundry Supply Co.

WAREHOUSES:
DETROIT, MICH.
WINDSOR, ONT.

Facing
ire Brick
oundry Supplies
oundry Equipment

FACING MILLS:
DETROIT, MICH.

Facings:

Detroit Foundry Supply Co., Detroit.
Dixon Crucible Co., Jos., Jersey City.
Doggett, Stanley, New York.
Hill & Griffith Co., Cincinnati.
MacKellar's, R. Sons Co., Peekskill, N. Y.
McCormick, J. S. Co., Pittsburg.
Obermayer, S. Co., Cincinnati.
Paxson, J. W. Co., Philadelphia.
Pettinos Bros., Bethlehem, Pa.
Stevens, F. B., Detroit.
United States Graphite Co., The, Saginaw, Mich.

Fans:

American Blower Co., Detroit.

Ferro-Manganese:

Metallic Alloys Co., New York City.
Rogers, Brown & Co., Cincinnati.
Western Foundry Supply Co., E. St. Louis, Ill., New York City.

Ferro-Silicon:

Roessler & Hasslacher Chemical Co., New York.
Western Foundry Supply Co., E. St. Louis, Ill., New York City.

Fillers (Metallic):

Clark Cast Steel Cement Co., Shelton, Conn.
Shanafelt Mfg. Co., Canton, O.
Shelton Metallic Filler Co., Derby, Conn.
Smooth-On Mfg. Co., Jersey City.

Fillets (Leather & Wood):

Shanafelt Mfg. Co., Canton, O.

Fire Brick:

Borgner Co., Cyrus, Philadelphia.
Detroit Foundry Supply Co., Detroit.
Gautier, J. H. & Co., Jersey City.
Harbison & Walker, Pittsburg.
Maurer, Henry, & Son, New York.
Laclede Fire Brick Mfg. Co., St. Louis.
Paxson, J. W. Co., Philadelphia.
Wm. Penn., Silica Works, Wm. Penn, P. O., Philadelphia.

Fire Sand:

Carborundum Co., Niagara Falls, N. Y.

Flasks:

Adams Co., Dubuque, Ia.
Barnett, Oscar, Fdy. Co., Newark.
Brass Founders' Supply Co., Newark.
Killing Molding Machine Co., Davenport, Ia.

Flasks (Snap):

Adams Co., Dubuque, Ia.
Diamond Clamp & Flask Co., Richmond, Ind.
Killing Molding Machine Co., Davenport, Ia.
Obermayer, S. Co., Cincinnati.
Paxson, J. W. Co., Philadelphia.

Flux:

Basic Chemical Co., Evansville, Ind.

Foundry Equipment (Iron & Brass):

Barnett, Oscar, Foundry Co., Newark.
Etting, Edward J., Philadelphia.
Morton Mfg. Co., Muskegon Heights, Mich.
New England Eng. & Equip. Co., Boston, Mass.
Northern Engrng. Works, Detroit.
Obermayer, S. Co., Cincinnati.
Pangborn, Thos. W. Co., New York.
Sly, W. W. Mfg. Co., Cleveland.
Standard Sand & Machine Co., Cleveland.
Stevens, F. B., Detroit.
Taylor, Robert J., Inc., Philadelphia.
Wonham & Magor, New York.

Foundry Supplies:

Central Foundry Supply, Columbus, O.
Crivel & Co., Geo. F., Buffalo.
Detroit Foundry Supply Co., Detroit.
Hill & Griffith Co., Cincinnati.
McCormick, J. S. Co., Pittsburg.
Obermayer, S. Co., Cincinnati.
Osborn Mfg. Co., Cleveland.
Pangborn, Thos. W. Co., New York.
Paxson, J. W. Co., Philadelphia.
Smith, J. D., Foundry Supply Co., Cleveland.
Stevens, F. B., Detroit.
Taylor, A. L., San Francisco.
Taylor, Robert J., Inc., Philadelphia.
Whitehead Bros. Co., New York, Providence, Buffalo.

Furnaces (Melting):

Barnett, Oscar, Foundry Co., Newark, N. J.
Fisher, Alfred, Chicago.
Hawley Down Draft Furnace Co., Chicago.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson, J. W. Co., Philadelphia.
Rockwell Engineering Co., New York.

Graphite:

U. S. Graphite Co., The, Saginaw.
Dixon Crucible Co., Jos., Jersey City.

Grinding Machinery:

Adams Co., Dubuque, Ia.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinding Wheels:

Norton Co., Worcester, Mass.

Hammers:

Independent Pneumatic Tool Co., Chicago and New York.

Hammers (Pneumatic):

Chicago Pneumatic Tool Co., Chicago.

Heating & Ventilating Apparatus:

American Blower Co., Detroit.
Sturtevant, B. F., Co., HydePark, Mass.

Hoists:

Box & Co., Alfred, Philadelphia.
General Pneumatic Tool Co., Montour Falls, N. Y.
Harrington, Edwin, Son & Co., Philadelphia.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee.
Sellers, William, & Co., Inc., Philadelphia.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York.

Hoists (Electric):

Northern Engrng. Works, Detroit.
Yale & Towne Mfg. Co., New York.

Hoists (Hand):

Northern Engrng. Works, Detroit.

Hoists (Pneumatic):

Chicago Pneumatic Tool Co., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Ridgway, Craig, & Son, Coatesville, Pa.

Industrial Ry. Equipment.

Atlas Car & Mfg. Co., Cleveland.

Iron Ore:

Rogers, Brown & Co., Cincinnati.

Magnets (Lifting):

Electric Controller & Supply Co., Cleveland.

Molding Machines:

Adams Co., Dubuque, Ia.
Arcade Manufacturing Co., Freeport, Ill.
Berkshire Mfg. Co., Cleveland.
Herman Pneumatic Machine Co., Zelienople, Pa.
Killing Molding Machine Co., Davenport, Ia.
Manning, Maxwell & Moore, New York.
Mitchell-Parks Mfg. Co., St. Louis.
Mumford, E. H. Co., Philadelphia.
Paxson, J. W. Co., Philadelphia.
Pridmore, Henry E., Chicago.
Rathbone, John A., Detroit.
Smith, J. D., Foundry Supply Co., Cleveland.
Tabor Mfg. Co., Philadelphia.

Packing (Rubber Sheet):

Smooth-On Mfg. Co., Jersey City.

Parting Compounds:

Doggett, Stanley, New York.
Foundry Specialty Co., Cincinnati.
Partamol Co., New York.
Smyth, Swoboda & Co., New York.

Pattern Letters.

Pattern Letter Co., Taunton, Mass.

Pattern Makers' Supplies:

Cleveland Fillet Co., Cleveland.

Patterns (Metal and Wood):

Herman Pneumatic Machine Co., Zelienople, Pa.

Pattern Shop Equipment:

Fox Machine Co., Grand Rapids, Mich.

Phosphorizers:

McCullough-Dalzell Crucible Co., Pittsburg.
New Era Mfg. Co., Kalamazoo.

Pig Iron:

Addy, Mathew, & Co., Cincinnati.
Bartlett, N. S. & Co., Boston.
Columbus Iron & Steel Co., Columbus.
DeCamp Bros. & Yule, St. Louis.
Domhoff & Joyce Co., Cincinnati.
Field, Robt., Sales Agency, Cincinnati
Goodrich, F. A., & Co., Detroit.
McKeefrey & Co., Leetonia, O.
Mohr, J. J., Philadelphia.
Nash, Isham & Co., New York.
Pickands, Brown & Co., Chicago.
Pickands, Mather & Co., Cleveland.
Pilling & Crane, Philadelphia.
Rogers, Brown & Co., Cincinnati.
Shepard, Chas. G., Buffalo.
Stevens, F. B., Detroit.
Superior Charcoal Iron Co., Grand Rapids, Mich.
Thomas Furnace Co., Milwaukee.

With the Injector Sand Blast Apparatus

Steel, Iron, and Brass Castings are cleaned with the least expense. Adapted to high or low air pressures.

Write for "Sandcraft."

Made by C. DRUCKLIEB,

132 Reade St., NEW YORK.

SALES AGENTS:

Harron, Rickard & McCone, Ltd., San Francisco and Los Angeles, Cal.
W. R. Colcord Machinery Co., - - - - St. Louis, Mo.
The E. A. Kinsey Co., - - - - - - Cincinnati, Ohio
The Fairbanks Co., - - - - - - New Orleans, La.
Zimmerman-Wells-Brown Co., - - - - Portland, Ore.
Detroit Foundry Supply Co., - - - - Detroit, Mich.
Canadian Rand Co., - - Montreal and Toronto, Canada.

ESTABLISHED 1875.

Stow Mfg. Co.

BINGHAMTON, N. Y.

INVENTORS OF THE

FLEXIBLE SHAFT

FOR ALL PURPOSES.

The oldest and largest manufacturers in the world.

PORTABLE EMERY GRINDER

Take the Tool to the Work and Save Heavy Handling.

WRITE US FOR CATALOGUE AND PRICES.

General European Agents: Messrs. Selig, Sonnenthal & Co., 85 Queen Victoria St., London, Eng.

CARBORUNDUM NIAGARA FALLS

Carborundum Grinding Wheels

Cut faster---

Last longer---

Do more work in a day

And last more days before wearing out than any other grinding wheel ever made.

CARBORUNDUM

is the ideal abrasive---And there is a Carborundum grinding wheel for every possible need.

Let our experts find the one best suited to your requirements.

The Carborundum Co.

Niagara Falls, N. Y.

United Iron & Steel Co., Pittsburg.
Walter-Wallingford & Co., Cincinnati and Pittsburg.

Plumbago:
Dixon Crucible Co., Jos., Jersey City.
Gautier, J. H., & Co., Jersey City.
Hill & Griffith Co., Cincinnati.
McCormick Co., J. S., Pittsburg.
McCullough-Dalzell Crucible Co., Pittsburg.
Obermayer, S. Co., Cincinnati.
Pettinos Bros., Bethlehem, Pa.
Ross-Tacony Crucible Co., Philadelphia.
Smith, J. D., Foundry Supply Co., Cleveland.
Stevens, F. B., Detroit.
Whitehead Bros. Co., New York, Providence, Buffalo.

Polishers' and Planers' Supplies:
Stevens, F. B., Detroit.

Riddles:
Adams Co., Dubuque, Ia.

Sand:
Pangborn, Thos. W. Co., New York.
Pinkston Sand Co., Michigan City, Ind.
Standard Sand & Machine Co., Cleveland.
Stevens, F. B., Detroit.
Waldie & McCauley Sand Co., The, New York.
Whitehead Bros. Co., New York, Providence, Buffalo.

Sand Blast Machinery:
Drucklieb, C., New York.
Pangborn, Thos. W. Co., New York.
Paxson, J. W. Co., Philadelphia.
Tilghman-Brooksbank Sand Blast Co., Philadelphia.

Sand Mixing Machinery:
Falls Rivet & Machine Co., Cuyahoga Falls, O.
Mumford, E. H., Philadelphia.
Pangborn, Thos. W. Co., New York.
Sellers, William & Co., Inc., Philadelphia.
Standard Sand & Machine Co., Cleveland.

Sand Sifters:
Chicago Pneumatic Tool Co., Chicago.
Deane Steam Pump Co., Holyoke, Mass.
Hanna Engrng. Works, Chicago.
Herman Pneumatic Machine Co., Zelienople, Pa.
Killing Molding Machine Co., Davenport, Ia.
Standard Sand & Machine Co., Cleveland.
U. S. Chaplet Supply Co., New York.

Saws (Cold Cutting):
Tabor Mfg. Co., Philadelphia.

Seacoal:
Obermayer, S. Co., Cincinnati.
Whitehead Brothers Co., New York, Providence, Buffalo.

Separators (Magnetic):
Dings Electro Magnetic Sep. Co., Milwaukee.
Elm City Engineering Co., New Haven.
Pangborn, Thos. W. Co., New York.

Shafting (Flexible):
Stow Mfg. Co., Binghamton, N. Y.

Shapers:
Morton Mfg. Co., Muskegon Heights, Mich.

Shovels:
Osborn Mfg. Co., Cleveland.
Stevens, F. B., Detroit.

Sprue Cutters:
Barnett, Oscar, Fdy. Co., Newark.
Shuster, F. B., Co., New Haven.
Middleditch, Benj., Detroit.
Turner Machine Co., Philadelphia.

Stoppers:
McCullough-Dalzell Crucible Co., Pittsburg.
Ross-Tacony Crucible Co., Philadelphia.
Taylor, Robert J., Inc., Philadelphia.

Testing Machines:
Keep, W. J., Detroit.

Thermit Process:
Goldschmidt Thermit Co., New York.

Tools (Molders'):
Dobson, William, Canastota, N. Y.
Obermayer, S. Co., Cincinnati.
Paxson, J. W. Co., Philadelphia.
Peninsular Tool & Specialty Co., Detroit, Mich.

Tramrail Systems:
Moyer Tramrail Co., Philadelphia.

Trolleys:
Pawling & Harnischfeger, Milwaukee.

Tumbling Mills:
Adams Co., Dubuque, Ia.
Falls Rivet & Mch. Co., Cuyahoga Falls, O.
Gilmour, J., New York.
Sly, W. W., Mfg. Co., Cleveland.

Turbines:
Kerr Turbine Co., Wellsville, N. Y.

Wax Wire:
Field, Alfred & Co., New York City.

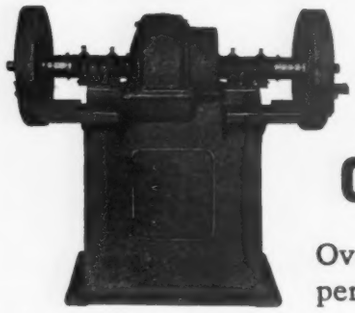
Wire Straighteners:
Blake, Geo. F., Mfg. Co., New York City.
Shuster, F. B. Co., New Haven.

Monarch Emery and Corundum Wheels

Monarch vitrified wheels are made from the purest materials, bonded together in a way that produces the greatest strength in texture. Porous, free-grinding, durable, evenly tempered. Work equally well wet or dry.

Our Catalogue C shows the large variety of styles for the different makes of machines, and tells all about them. Write for it.

Monarch Emery & Corundum Wheel Company, Camden, N. J.



Motor Driven Grinders

Over 25 year's experience making grinders. We know how.

The Bridgeport Safety Emery Wheel Co. (Inc.)
Bridgeport, Conn.

Air Compressors

Send for Catalogue

Pneumatic Chipping Hammers, Hoists, Casting Cleaners, Sand Blast Machines, Molding Machines and other appliances in foundry work.

American Air Compressor Works
26 Cortlandt St. NEW YORK

Thor

AIR TOOLS ARE SUPREME

Mechanically and Economically

Adopted as the Standard in the Principal Foundries Throughout the World

Thor No. 2 Chipping Hammer.
Especially adapted to foundry work.
Easiest to operate. Gives best results.

Made in all sizes covering every Air Tool requirement.

Sent on trial at our expense.

Thor
No. 7.
The only successful Pneumatic Portable Grinding Machine

Designed for grinding castings, polishing, buffing, etc.

Write for our new catalog.

Independent Pneumatic Tool Co.

MANUFACTURERS OF

Piston Air Drills, Reaming, Tapping, Reversible Flue Rolling and Wood Boring Machines, Pneumatic Riveting, Chipping, Calking and Beading Hammers and Air Appliances of Every Description.

General Offices: First National Bank Bldg., CHICAGO **Eastern Offices: 170 Broadway, NEW YORK CITY**

PITTSBURG, PA., 1210 Farmers Bank Bldg. **SAN FRANCISCO, CAL., 61 Fremont St.**

"Your inquiry means your order."

Batcheller, Clark & Batcheller,

BUILDERS

Electric and Hand Power Traveling Cranes.
Jib Cranes and Derricks for every service.

NEW YORK OFFICE:
107 Liberty Street.

WORKS: { **240-6 North Tenth Street,**
274-84 Union Avenue.
BROOKLYN, N. Y.

Foundry Cost Systems That Increase the Profit

Where Is My Profit?

WAITING FOR AN ANNUAL INVENTORY, TO DETERMINE THE AMOUNT OF YOUR PROFIT, MAY LEAVE YOU WITH EMPTY POCKETS. If your business is small and you do not want to be at the expense of my PERSONAL SERVICE AT YOUR FOUNDRY, get a Set of my Practical Foundry Cost Records. These will enable you to install a cost system that will show the amount of profit, each month, on each customer's sales. This is not merely a printed book but full size forms and records, ruled as required by actual practice; with a 60 page book of printed instructions. My methods are practical and economical to use. Seventeen years practical experience in the foundry, enables me to arrange the most SIMPLE, PRACTICAL and PROFITABLE systems of any one offering to install foundry cost systems. Every foundryman is interested in increasing his profits; let us correspond about it. Address

JAMES C. LOUGHRY **ELYRIA, OHIO**

The Practical Foundry Cost Man

CLASSIFIED ADVERTISEMENTS

Wanted and For Sale advertisements 40 cents a line. Positions and Help Wanted 25 cents a line. Count seven words to the line.

FOUNDRY FOREMAN WANTED

FOUNDRY FOREMAN WANTED IN middle western city, for foundry force of about 20 men, on a good class of medium and heavy machinery castings; a progressive man capable of helping to develop a growing business. State age, experience as molder and as foreman, knowledge of mixtures and molding machines, lowest salary you would start at. Address Box 675, THE FOUNDRY, Cleveland, O.

FIRST CLASS FOREMAN WANTED, having strictly temperate habits and good character, for malleable iron foundry running upon molding machine work and miscellaneous work covered by a large variety of intricate patterns. Applicant must have some technical knowledge, good executive ability and skill in handling men. Thorough acquaintance in handling work to best advantage, are indispensable. Expert consultation with respect to malleable iron mixtures would be available. Address Box 680, THE FOUNDRY, Cleveland, O.

FOUNDRY FOREMAN WANTED FOR large radiator works situated in Canada. Must have practical experience and be thoroughly conversant with all details in connection with radiator work and familiar with modern, up-to-date cupola practice. None but competent men need apply. State age, experience, references and salary expected. Address Box 676, THE FOUNDRY, Cleveland, Ohio.

FOUNDRY FOREMAN WANTED FAMiliar with bench, squeezer and molding machine work. Open shop. State reference and salary wanted. Address Box 673, THE FOUNDRY, Cleveland, O.

ASSISTANT FOUNDRY FOREMAN wanted, a young man who has had experience on light work on benches and molding machines. Good position for right man. State fully age, experience and salary expected. Address Box 682, THE FOUNDRY, Cleveland, O.

CORE ROOM HELP WANTED

EXPERIENCED COREMAKERS WANTed for southern pipe foundry. Good wages and steady work. Address P. O. Box 81, Birmingham, Ala.

MOLDERS WANTED

AN EXPERIENCED MOLDER WANTed, familiar with cylinder work. Give full details of experience and wages. The Shepherd Engineering Co., Williamsport, Pa.

A COMPETENT MOLDER WANTED with small capital to take interest in and charge of small foundry connected with machine shop 40 miles from San Francisco, finest locality and climate. Fine opening for reliable worker. Address Box 678, THE FOUNDRY, Cleveland, O.

HELP WANTED, MISCELLANEOUS

TECHNICAL MEN. WITH OFFICES IN principal cities in America, we offer technical men a service reaching every great industry in the world. We have placed men in India, China, South America, Cuba and Panama. Openings today for hundreds of Superintendents, Engineers, Draftsmen, Managers, and Foremen, from $900 to $10,000. Write for list of Opportunities, and location of nearest office. HAPGOODS, 305 Broadway, New York City.

FOREMAN WANTED FOR ANNEALING Department, ten ovens, malleable foundry. Address Box 646, THE FOUNDRY, Cleveland, Ohio.

SUPERINTENDENTS WANT POSITIONS

POSITION WANTED AS SUPERINtendent or foreman by a practical foundryman, who has had a large general experience in managing foundries making light gray iron, hot water, and steam boiler castings. Has good executive ability and can handle a large or small foundry economically. Address Box 686, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT WILL be open for engagement Jan. 1. Steam and hot water boilers and radiators 15 years' experience. References A-1. Address Box 692, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS SUPERINtendent of a malleable or grey iron plant. Thirty years' practical experience. Thoroughly understands molding machines in every detail. Expert mixer and melter of metal. A thorough organizer. Can design, erect, equip and manage your plant. A-1 references. Address Box 662, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS SUPERINtendent or foundry foreman in a stove plant. Am practical and experienced; nine years in present position. Am anxious to change location. Reference exchanged as to character, habits, ability, etc. Address Box 681, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT OR GENeral foreman, at present employed, desires a change. East preferred. Stove plate and hot air furnace work a specialty. Wide experience. A-1 references. Address Box 693, THE FOUNDRY, Cleveland, O.

POSITION WANTED FIRST OF THE year. Experienced as superintendent in all departments, including mixing of iron, coremaking, molding machine work, on cast iron heaters, radiators, flanged and screwed fittings. Small city preferred. Address Box 688, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT, AT present employed, would like to correspond with a first-class firm desiring to make a change. Wide experience on all classes of light work. Have handled 500 molders. Thorough organizer, modern in shop and cupola practice, machines, etc. Address Box 695, THE FOUNDRY, Cleveland, O.

SITUATION WANTED AS ASSISTANT superintendent in malleable or grey iron plant. Age 28, nine years' practical experience in mixing, melting and annealing. Good cost accountant, proficient in speeding help. Address Box 663, THE FOUNDRY, Cleveland, O.

POSITION AS SUPERINTENDENT OR foreman wanted, in Foundry. Am 44 years of age, have had 20 years' experience in charge of Foundry producing high-grade heavy, medium and light castings with an output of 80 tons per day. Can introduce latest methods in green loam and dry sand. Well up in cupola practice and mixtures of metals. Will furnish references. Address Box 615, THE FOUNDRY, Cleveland, Ohio.

POSITION WANTED AS SUPERINtendent or foreman by up-to-date gray iron foundryman experienced in cupola and molding machines, or as assistant Superintendent in malleable Iron Plant. Good references, sober and a hustler. Address Box 689, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOUNDRY SUperintendent or superintendent of several foundries by a competent foundryman, one familiar with every detail connected with foundry work and able to put one or more foundries on a systematic working basis. Good executive ability; at present holding responsible position. Address Box 1,000, care THE FOUNDRY, 1362 Monadnock Block, Chicago, Ill.

POSITION WANTED AS SUPERINtendent of malleable iron plant; 25 years' experience on light work. Address Box 683, THE FOUNDRY, Cleveland, O.

FOREMANSHIP WANTED

POSITION WANTED BY A RELIABLE, energetic foundry foreman. Experienced in machine tool and jobbing work. Open for immediate engagement. References from present employers. Correspondence solicited. Address Box 672, THE FOUNDRY, Cleveland, O.

POSITION WANTED BY A GENERAL foundry foreman who understands the foundry business in all its details. Will be open for a change Jan. 1, experience from boyhood up on all classes of gray iron work. Have at present a large foundry in charge, but have reasons for wishing a change. Can furnish best reference. Address Box 687, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOREMAN. Young man with 17 years' experience in light and medium gray iron. Experienced in molding machines and cupola practic. Address Box 677, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOREMAN IN gray iron shop. Stove, range, furnace or light jobbing work preferred. Understand cupola and mixing of iron. Have had 15 years' experience and can furnish references. Address Box 684, THE FOUNDRY, Cleveland, O.

FOUNDRY FOREMAN WISHES TO make a change. Correspondence solicited. First-class references. Address Box 671, THE FOUNDRY, Cleveland, O.

GENERAL FOREMAN DESIRES A change, at present employed. East preferred. Thorough organizer and practical foundryman. Stove or heater work preferred. Address Box 694, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOREMAN BY a practical foundryman. Twenty-five years' experience at the trade. Foreman fifteen years. Good gray iron mixer. Thoroughly familiar with cupola practice and molding machines. High class reference. Address Box 690, THE FOUNDRY, Cleveland, O.

PATTERNSHOP HELP

POSITION WANTED AS SUPERINtendent of pattern shop or machine shop by one who was for 20 years superintendent of a large pattern shop. Recommended as being able to secure and hold men and get large results out of a low per capita pay roll. Address Box 657, THE FOUNDRY, Cleveland, O.

POSITIONS WANTED, MISCELLANEOUS

POSITION WANTED BY MELTER WITH 15 years' experience on foundry work, castings and forgings and nickel steel. Address Melter, 521 Park Bldg., Pittsburg, Pa.

PROPERTY FOR SALE

FOUNDRY FOR SALE ON LIBERAL terms complete with Soil Pipe equipment, or the equipment separately, consisting of a full line of pipe and fitting patterns, from 2 to 8 in. both light and heavy; 19 pipe machines, and over 1,000 fittings and patterns, staple sizes. Match Plated with iron flasks, 25,000 sq. ft. of molding space. Capacity of cupola from 50 to 60 tons a day. Blower, Cupola, Machines and Patterns all new. Buildings all of concrete and brick. Would consider taking in an active partner or consolidating with an A No. 1 concern. Only legitimate offers from good parties considered. Located centrally to Buffalo, Cleveland and Pittsburg. Address Box 605, THE FOUNDRY, Cleveland, Ohio.

FACTORY BUILDINGS FOR SALE, LOcation Anderson, Ind. Amount of ground, two acres. Amount of floor space, 26,000 square feet. Shipping facilities, on Belt Line used by Penn. and New York Central systems. The buildings are in elegant condition, offices equipped with furniture. A new steam producing plant with 90-horse boiler and 72-horse automatic engine, and electric light plant. Six-ton cupola, core oven, rattles, shafting and pulleys. Floor scales, fitting rooms and pattern vaults. This property will be sold or traded. Ross Supply Co., Greenville, O.

AN A-1 FOUNDRY FOR SALE, ALmost new; doing $50,000 worth of business annually and capable of doing $100,000; will leave a contract with purchaser and retain an interest in foundry. Other business necessitates discontinuing active interest. Address Box 629, THE FOUNDRY, Cleveland, Ohio.

COMPLETELY EQUIPPED PLANT FOR sale, for manufacture of plumbers' brass goods. Well located for New York trade. Plenty cheap non-union labor. Ample ground for expansion. Will sell outright or retain part interest. Address Box 608, THE FOUNDRY, Cleveland, O.

MACHINE SHOP, FOUNDRY AND WOOD shop for sale, doing a business of 100,000 dollars a year, with well established trade. Water power, good buildings and best of railroad facilities. Located in middle west. For particulars address Box 606, THE FOUNDRY, Cleveland, Ohio.

MODERN EQUIPPED FOUNDRY FOR sale or lease, with privilege of purchase on easy terms; located in the most thriving manufacturing city in the middle west. Business good, territory the best. Please investigate this proposition. Address Bartlett & Reintges, Granite City, Ill.

CONTROLLING INTEREST FOR SALE in foundry and machine shop. Splendid prospect. $25,000 required. For particulars address J. F. Smith, 315 Pioneer Bldg., Seattle, Wash.

BUSINESS OPPORTUNITIES

DO YOU WANT TO GET INTO THE molding machine business, and get the aid of an expert molding machine man to equip your foundry with machines? If so, write me. By the aid of many years' experience I have designed a very practical molding machine. I desire the financial aid of an enterprising foundryman to build and place same on the market. I am a careful business man, as well as a good mechanic, and understand the machine and foundry business. I seek a square deal. Address Box 674, THE FOUNDRY, Cleveland, O.

INVENTORS ATTENTION! AN ESTABlished firm, manufacturing foundry equipment, interested in up-to-date molding machines. Long experience, excellent facilities for manufacturing and selling. Address with description and particulars, Box 654, THE FOUNDRY, Cleveland, O.

INVENTORS ATTENTION: MERITOrious patented foundry machinery manufactured on royalty basis. Long experience and unexcelled facilities for reaching foundry trade. Whiting Foundry Equipment Company, Harvey (Chicago Suburb), Ill.

COMPETENT AND AMBITIOUS MOLDER can secure exceptional opportunity to get into business for himself. Foundry is side issue and we will give rental first year and if results are satisfactory will give partnership. Address Box 647, THE FOUNDRY, Cleveland, O.

WANTED TO INTEREST CAPITAL IN a Trade School Foundry. Apprentice Molders on Commercial castings. By experienced Foundryman and Instructor. Address Box 691, THE FOUNDRY, Cleveland, O.

BLOWERS FOR SALE

BLOWER BARGAINS.
Roots Second-Hand Blowers, bought, sold, or exchanged for new ones. Address,
H. M. PAPWORTH.
120-122 Liberty Street, New York City.

CUPOLAS FOR SALE

TWO SECOND-HAND CUPOLAS IN first-class condition. Shells 72"-82" in diameter and about 40 feet high. Box 800, THE FOUNDRY, Cleveland, O.

ENGINES FOR SALE

ONE 6 H. P. MEITZ & WEISS KEROsene engine for sale, also one 2½ H. P. In good condition. Low price. Lumen Bearing Co., Buffalo, N. Y.

GAS ENGINE FOR SALE, 6 H. P., WATkins, almost new, a bargain. Address the U. S. Aluminum Castings Co., Cincinnati, O.

MOLDING MACHINES FOR SALE

1 Mumford air squeezer, 44".
7 Farewell molding machines.
Practically all new. Write for information to A. Buch's Sons Co., Elizabethtown, Pa.

THREE 24-INCH HINGED TABOR molding machines for sale, also one 36-inch Hinged Tabor Molding Machine. The above are practically new and ready for immediate shipment at very much less rates than factory prices. The Exeter Machine Works, Pittston, Pa.

ONE MODERN MOLDING MACHINE for sale, which has been slightly used, made by the Arcade Mfg. Co., Freeport, Ill. Can be seen at our Chicago plant. Address Box 685, THE FOUNDRY, Cleveland, O.

FOUR ARCADE MOLDING MACHINES for sale at a sacrifice. Acme Steel & Malleable Iron Works, Buffalo, N. Y.

FOR SALE, MISCELLANEOUS

FOR SALE, SECOND HAND.
One each No. 4, No. 5 and No. 5½ Baker Blower.
One 20-ton Air Melting Furnace (Cupola).
Two Stationary and one Portable Millett Oven.
One Seller's Centrifugal Sand Mixer.
One 12-ton Geared Crane Ladle.
One 13-ton Geared Crane Ladle.
J. W. Paxson Co., Philadelphia, Pa.

COMPLETE OUTFIT FOR CHEMICAL analysis of iron for sale. The Snead & Co. Iron Works, Jersey City, N. J.

CASTINGS

SOFTER, STRONGER AND CLEANER gray iron castings can be made from cheaper iron, and they can be machined faster, by using Outerbridge Silicon Alloy. No expert required. Free sample. J. W. Paxson Co., Philadelphia, Pa.

FLUOR SPAR

FLUOR SPAR.—EVERY GRADE. QUOtations delivered anywhere. Cheapest suppliers. Address GEO. G. BLACKWELL SONS & CO., Ltd., Liverpool, Eng., or Agents, Penna. Salt Mfg. Co., Pittsburg, Pa.

FLUOR SPAR.—"ENGLISH." 45 TO 95 per cent fluor and 2 to 4 per cent silica—monthly arrivals. The British Mineral Co., represented by J. W. Paxson Co., Philadelphia, Pa.

FLUOR SPAR—BY THE BARREL, TON or car lots. Address American Fluor Spar Co., Paducah, Ky.

BLOWERS WANTED

TWO SECOND HAND POSITIVE PRESsure blowers wanted, similar in size to Root's No. 6 and No. 7. Address, quoting price and full description, Box 655, THE FOUNDRY, Cleveland, O.

FOUNDRY EQUIPMENT WANTED

SECOND-HAND FOUNDRY EQUIPMENT wanted, including Cupolas, Ladles, Tumbling Barrels, etc. Quote price and state condition. Address Box 885, THE FOUNDRY, Cleveland, Ohio.

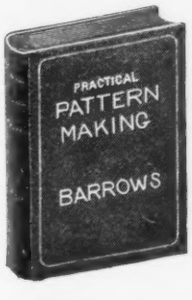
WORK WANTED

A WELL EQUIPPED MACHINE SHOP and foundry desires to add to its output by the manufacture of articles of brass and iron which would find a ready sale in the South. Correspondence invited. Address Box 544, THE FOUNDRY, Cleveland, O.

WANTED, MISCELLANEOUS

A 60-INCH CUPOLA WANTED, ALSO foundry rattles, sand mixer and ladles. Materne Manufacturing Company, St. Louis, Mo.

A New Work on Pattern Making



Just published
By F. W. Barrows
326 pages—fully illustrated.

This book is made up of material gathered from the personal experience of the author and is full of useful hints and original ideas. It is a complete treatise on pattern making, both in wood and metal. Individual patterns of many different kinds are illustrated and described and the mounting of metal patterns on plates for molding machines is included.

Price $2.00.

FOR SALE BY
THE PENTON PUBLISHING CO., Cleveland, O.

Superior Charcoal Iron Co.
MANUFACTURERS OF
Lake Superior Charcoal Pig Iron
Grand Rapids, Mich.

GET YOUR SHARE OF OUR
$100.00 OFFER
See The Foundry's Announcement on Page 156.
SEND IN YOUR STORY

NORTHERN CRANES

1 to 100 Tons
Capacity
Electric or Hand
AC or DC
All Types

They have
New Features
that will
Interest You

THE IDEAL CRANES FOR THE MODERN FOUNDRY

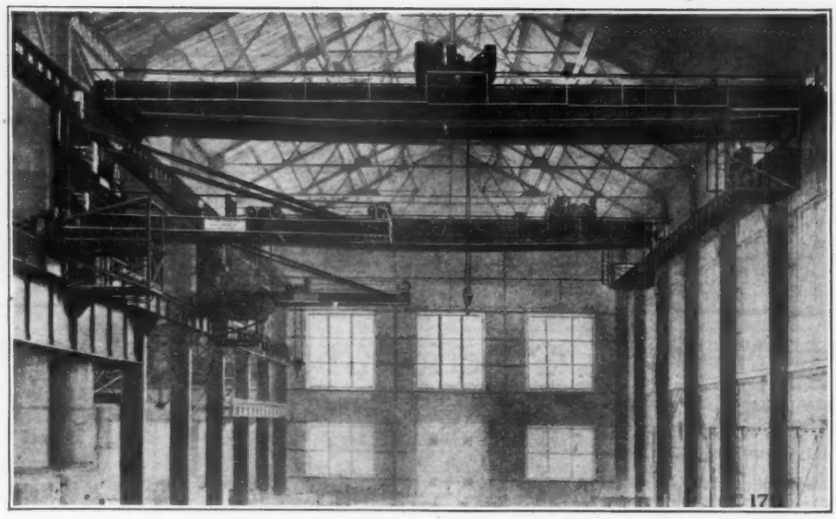
"THE BEST ELECTRIC TRAVELING CRANES MADE"

Northern Engineering Works

4 CHENE ST., DETROIT, MICH., U. S. A.

NEW YORK, 120 Liberty St.
ST. LOUIS, 720 N. 2nd St.
PHILADELPHIA, Land Title Bldg.
PITTSBURG, Machesney Bldg.
CHICAGO, 405 Monadnock Blk.
BUFFALO, 422 Prudential Bldg.

SHAW CRANES



can always be depended upon and that is why no other kind was installed

In the Foundry

or, in fact, the entire new plant of the Utica Pipe Foundry Co., where every other consideration was set aside

For Reliability

Let us tell you about this interesting installation.

Never Buy a Crane Before Investigating the Shaw

SOLE AGENTS

MANNING, MAXWELL & MOORE, Inc.

85-87-89 Liberty Street, New York

22-26 S. Canal St., Chicago
Kirk Bldg., Syracuse
721 Arch St., Philadelphia
Woodward Bldg., Bir'm, Ala.
128 Oliver St., Boston
Majestic Bldg., Detroit
Frisco Bldg., St. Louis
Merrill Bldg., Milwaukee
Park Bldg., Pittsburgh
Tokio, Japan
Williamson Bldg., Cleveland
Mexico City, Mexico